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# The vegetation of a historic road system in the suburban area of Monte Pellegrino (Palermo, Sicily)

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## Abstract

Knowledge of the processes by which plants colonize old structures is a key element for nature-based design both in urban and suburban contexts. This paper analyses the natural vegetation on walls and in other microhabitats of the roadway structures of Monte Pellegrino (606 m a.s.l.) near Palermo (Sicily), built in the first half of the 1900s. The historical road has particular construction and architectural features, and its characteristics have been maintained to this day. The route, approximately 16 kilometers long, is well integrated within a site of high naturalistic value which has been designated as a Special Area of Conservation (ITA020014) of the Natura 2000 network, and it is also a regional natural reserve. The survey was carried out on different homogeneous ecological contexts based on different microhabitats (masonry retaining walls, masonry guardwalls, road margins, and rock cut slopes) which are diversified according to other environmental factors (building materials, inclination, height, and exposure). The phytosociological and statistical analysis has led to the description of six new associations (*Crepido bursifoliae-Parietarietum judaicae* ass. nov., *Athamanto siculae-Parietarietum judaicae* ass. nov., *Helichryso panormitani-Hypochaeridetum laevigatae* ass. nov., *Diantho siculi-Helichrysetum panormitani* Gianguzzi ass. nov., *Olopto miliacei-Pennisetetum setacei* Gianguzzi ass. nov., *Teucrio flavi-Rhoetum coriariae* Gianguzzi ass. nov.) and one sub-association (*Rhamno alaterni-Euphorbietum dendroidis* Géhu & Biondi 1997 *artemisietosum arborescentis* subass. nov.). Other chasmophytic formations (*Centranthetum rubri* Oberd. 1969, *Antirrhinetum siculi* Bartolo & Brullo 1986) were reported for the first time in this area.

## Keywords

*Asplenietea trichomanis*, chasmophytic vegetation, colonization, man-made habitat, wall vegetation, syntaxonomy

## Introduction

Road systems have accompanied humans since their earliest civilizations, profoundly affecting ecosystems and landscape characteristics in many parts of the world. In addition, they also provide new anthropogenic habitats for flora and plant communities, as well as for fauna (Hobbs et al. 2006; Lososová et al. 2010; Bontoux et al. 2019). This is particularly relevant in suburban and rural areas where road systems are the primary artificial elements that shape their landscapes (Forman 2002).

Although road systems may differ according to their age, construction methods, and types of building materials, all these different systems form specific ecosystems due to the great variety of habitats they provide (walls, masonry parapets, road margins, cut slopes). Plants colonize these different habitats, driven by ecological gradients that define specific "microgeoseries" (*sensu* Rivas-Martínez 2002) for each environmental context.

Before the use of concrete as a building material, road routes made use of mortared masonry walls or dry-laid walls as retaining structures. These were built by specialized craftsmen who selected and shaped the rocks at the

work site, and surfaces were paved with cobblestones instead of asphalt. In Italy, as well as in various other areas of the Mediterranean, these types of road layouts are widespread today, although most of them have been modified by adding asphalt on top of the cobblestone layer. These kinds of roadways persist mainly in mountainous areas or in places with steep and rugged terrain where they resist exposure to severe weather conditions as well as the normal wear and tear that occurs over time. Overall, the architectural beauty of these works stands out, as does, in particular, the building effectiveness of the stone masonry walls which bridge differences in height by creating steep hairpin bends on mountainsides. These structures characterize mountain landscapes like that of the Stelvio Pass's hairpin bends (Pedrana 2011), but they also feature in the tight curves of Monte Pellegrino, near Palermo (the study area of this paper), their presence a testimony to the endurance of human workmanship.

The old structures of road systems offer considerable new spaces for plant colonization and are covered by plant communities which are micromorphologically diversified in relation to their floristic and physiognomic aspects (inclination, exposition, height of surfaces).

A number of botanical and ecological studies of suburban road systems have focused on the role of road margins primarily as corridors for the diffusion of allochthonous species that use these communication routes as expansion corridors (Kowarick 2003; Kalwij et al. 2008; McDougall et al. 2018; Pasta et al. 2010). On the contrary, other authors have considered road margins as refuge habitat for native plants in highly disturbed landscapes such as urban areas or near industrial or intensive agricultural systems (Forman and Alexander 1998; Rentch et al. 2005; Arenas et al. 2017; Lázaro-Lobo and Ervin 2019). With regard to the walls involved in these roadways, *sensu lato*, research on vegetation has especially highlighted the role of plants as biodeteriogens of artifacts of cultural interest (Caneva et al. 1992, 1995; Caneva and Ceschin 2009; Ceschin et al. 2006, 2016; Li et al. 2016). Plant communities growing on ancient walls have been analyzed both from an ecological-conservation point of view – as a refuge habitat for specialized flora (Segal, 1969; Meral et al. 2018; Huang et al. 2019) – as well as in phytosociological terms, through the characterization of specific syntaxa (Hruška 1987; Brullo and Guarino 1998, 2002; Gamper and Bacchetta 2001). Road cut slopes have also been the subject of specific studies that have analyzed colonization processes and similarities with natural rock communities (Bochet et al. 2009).

The aim of this work is the phytosociological investigation of vegetation on walls and in other microhabitats of the road system of Monte Pellegrino (the mountain towering above the city of Palermo) and the interpretation of species composition patterns of plant communities along the roadway structures. The road system can be considered "historical"; in fact, it was inaugurated in 1924. Its route, approximately 16 kilometers long, climbs along the slopes of the mountain with hairpin bends and short straightaways, and it is well integrated within an area of particular naturalistic value which has been designated as a Special Area of Conservation (ITA020014) of the Natura 2000 network and is a regional natural reserve.

The study also addresses the issue of bio-ecological and phytocoenotic stability established in the road system that has been triggered by the slow colonization process within the different microhabitats (masonry retaining walls, masonry guardwalls, road margins, and rock cut slopes) and which are diversified according to other environmental factors (building materials, inclination, height, and exposure).

There are not many other studies in the Mediterranean area about plants growing on all components of a road system. Therefore, the data collected are suitable for two practical applications: (I) knowledge of so-called biodeteriogens that can be of use for the conservation of road artefacts; (II) potential use of the plants of the investigated communities for the sustainable design of environmental redevelopment interventions or mitigation measures (e.g., for excavations, rock cuts, cut slopes, fill slopes, walls, etc.).

# Materials and methods

## Study area

The road system under investigation climbs up Monte Pellegrino (606 m a.s.l.), a well-known limestone mountain that rises to the northwest of Palermo in the northern coastal belt of Sicily (Hutchinson 1959). It has an elongated shape, with its major axes oriented from southeast to northwest, toward the Palermo plain. The topography is characterized by steep slopes and subvertical cliffs associated with subhorizontal planes (Fig. 1).

In terms of the geological setting, the study area is part of the Apennine–Maghrebian chain (Grasso, 2001). The lithostratigraphy is characterized by different formations described by Basilone (2018) within the Panormide carbonate platform successions (Upper Triassic to Lower Miocene), in particular, the following outcrops: a) the Pellegrino Formation (along the western side), that consists of massive rudistid boundstones and floatsones alternating with blackish laminated mudstone, stromatolitic and loferitic packstone, and bioclastic packstone; b) the Capo Gallo limestone formation (on the central part), that consists of well-stratified grey limestone (wackestone/packstone) alternating with blackish oolitic grainstone; c) the Piano Battaglia limestone formation (along the eastern and southern sides) that consists of massive grey reef limestones, calcareous breccias, and oolite grainstone; the Cozzo di Lupo formation that consists of Spongid reef limestones alternating with calcareous breccias and calcarenites (grainstone-packstone); d) scree and debris flow mainly concentrated along the sides of mountains (Basilone 2018).

In terms of climate, the study published by Duro et al. (1996) shows an average annual daytime temperature of 18.1 °C, while the average annual maximum temperature is 22.5 °C, and the average annual minimum temperature is 13.7 °C. The coldest month of the year is January (monthly mean minimum = 7.8 °C, monthly mean maximum = 15.7 °C), and the warmest month is August (monthly mean minimum = 20.8 °C, monthly mean maximum = 29.9 °C). Mean annual precipitation data (mm) on the Palermo plain, measured at different weather stations, show 679.4 mm (Istituto Castelnuovo), 643.7 mm (Servizio Idrografico) and 584.1 mm (Osservatorio Astronomico), corresponding to, respectively, 78, 73, and 71 rain days (Gianguzzi et al. 2013, 2015a).

Bioclimatic indices of the area, calculated according to Rivas-Martínez et al. (2011), allowed the definition of different thermotypes and ombrotypes in relation to land elevation as follows: a) Upper Thermomediterranean Lower Dry; b) Upper Thermomediterranean Upper Dry; c) Upper Thermomediterranean Lower Subhumid; d) Lower Mesomediterranean Lower Subhumid (Bazan et al. 2015; Gianguzzi et al. 2015b).

On the northern slopes, the local bioclimate tends to be Thermo-Mesomediterranean, from sub-humid to humid, due to the high cliffs shaped like a north-facing theater. Here, the vegetation consists of *Rhamno alaterni-Querco ilicis pistacio terebinthi* sigmetosum. In this vegetation series, the mature formation is a wood dominated by *Quercus ilex* and characterized by the presence of thermophilous deciduous broadleaves such as *Pistacia terebinthus* and *Rhus coriaria*. The seral stages are more frequently represented by maquis, dominated by the above-mentioned deciduous broadleaves and by perennial dry grasslands o *Helictotricho-Ampelodesmetum mauritanici* (Gianguzzi et al. 1996).

On the western and southwestern sides of Monte Pellegrino, contrasting microclimatic conditions, created by different slope aspects and steepness, result in a tendency towards the Thermomediterranean lower dry (also verging on the Inframediterranean). Climatophilous vegetation can be referred to the oleaster series (*Ruto chalepensis-Oleo sylvestris* sigmetum), whose head of series is the *Olea europaea* var. *sylvestris* xerophilous wood (Gianguzzi and Bazan 2019, 2020; Gianguzzi et al. 2020). The successional stages of the series are represented by *Euphorbia dendroides* garrigue (*Rhamno-Euphorbietum dendroidis* s.l.) and xerophilous *Hyparrhenia hirta* grassland (*Hyparrhenietum hirto-pubescentis* s.l.) which, in recent years, tends to be replaced by the alien invasive grassland Pennisetum setaceum (*Penniseto setacei-Hyparrenietum hirtae*), probably due to climate warming (Pasta et al. 2010). Communities dominated by therophytes (e.g. *Thero-Sedetum caerulei*, *Stipellula capensis* micro-communities, etc.) also belong to the same vegetation series.

On the eastern sides, the bioclimate is Thermomediterranean and ranges from upper dry to lower subhumid (north-east). Climatophilous vegetation is represented by a more xerophilous holm oak series (*Rhamno alaterni-Querco ilicis pistacio lentisci* sigmetosum) in which *Hyparrhenia hirta* grassland (*Hyparrenietum hirtae* s.l.) is the most significant and widespread degradation aspect.

The three climatophilous series come into contact with the microgeosigmeta of the inland cliff communities of the alliance *Dianthion rupicolae* (*Asplenietea trichomanis*), such as *Scabioso creticae-Centaureetum ucriae* (Gianguzzi et al. 1996).

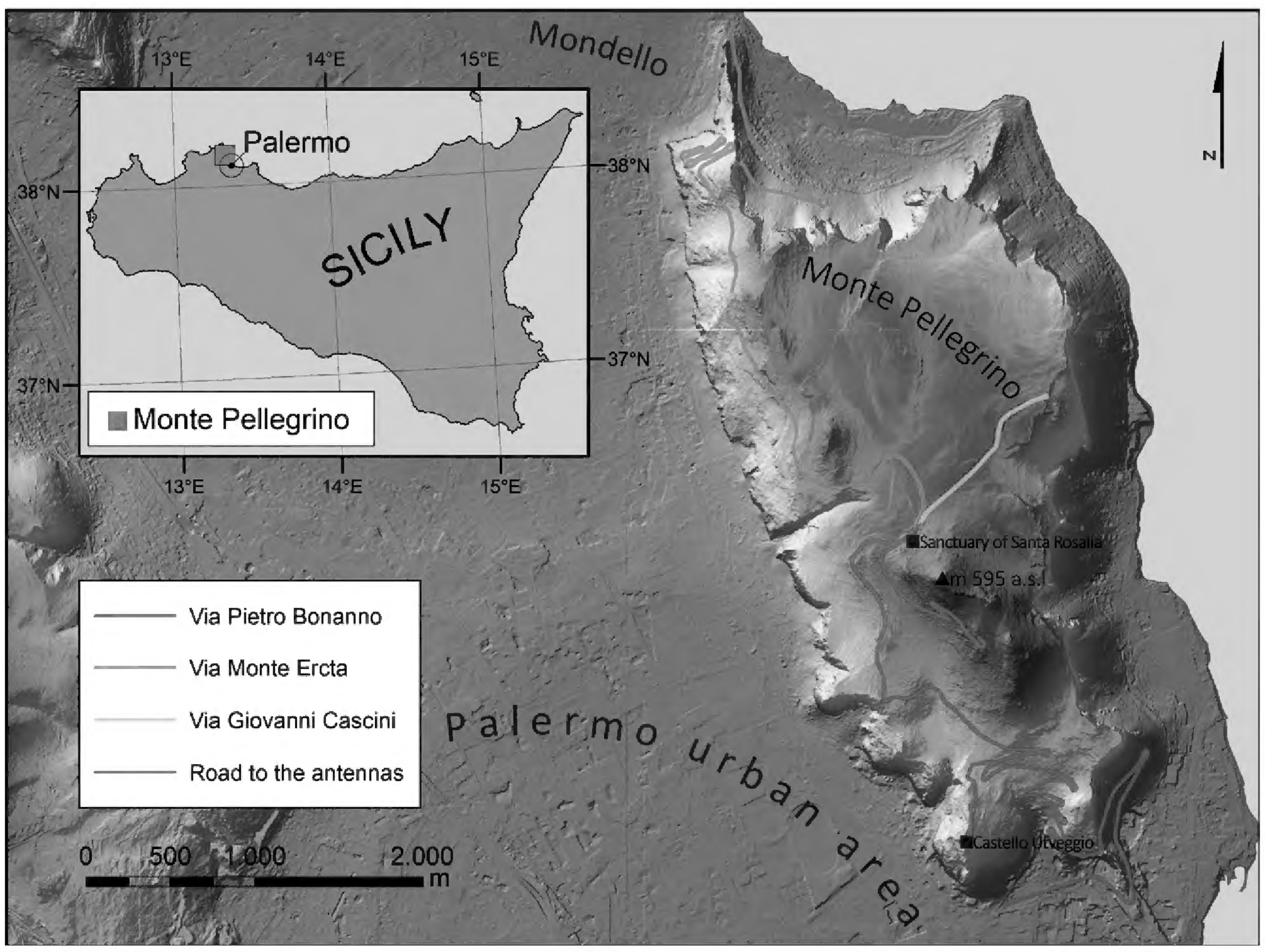


**Figure 1.** Location of the Monte Pellegrino road system.

Monte Pellegrino's vegetation mosaic hosts a rich flora, counting 741 infrageneric taxa (Raimondo et al. 1996), which includes some rupicolous endemic species and taxa of biogeographic interest, such as: *Iberis semperflorens*, *Glandora rosmarinifolia*, *Centaurea panormitana*, *Helichrysum panormitanum*, *Seseli bocconei*, *Micromeria fruticulosa* and *Brassica rupestris*.

Archaeological evidence in the Allaura caves (on the northern slopes of the mountain) dates the human presence in the area back to the Upper Paleolithic period (Mannino et al. 2011), testifying to a thousand-year-old exploitation of Monte Pellegrino's natural resources. Despite the historical land-use of the territory, the area has maintained a high level of biodiversity as a result of a long-term interaction between humans and nature, as has also been pointed out for other areas of Sicily (Guarino and Pasta 2017; Bazan et al. 2019, 2020; Musarella et al. 2018; Todaro et al. 2020).

However, due to its proximity to the city of Palermo, the protected area has been affected by anthropic disturbances, such as recurring fires, a prevalence (in terms of biomass) of exotic species over native ones, and waste dumping that afflicts even the most inaccessible areas, which damage the site's natural heritage.

## Historical notes on the road system

The road system of Monte Pellegrino is located within the administrative area of the City of Palermo and, consequently, the roads are named following the toponyms of the urban streets. It is divided in four parts (Fig. 1), as follows: 1) via Pietro Bonanno, located on the southwestern side, connects the city of Palermo to the Sanctuary of Santa Rosalia; 2) via Monte Ercta (also called "Panoramica"), on the northwestern side, connects the Sanctuary of Santa Rosalia to the Mondello area; 3) via Giordano Cascini is the road between the Sanctuary and the panoramic lookout on the northeastern slope of the mountain; 4) a (nameless) service road that climbs from the Sanctuary to the antennas (578 m a.s.l.) on the top of the mountain.

The first two stretches of the road system, with a total length of 16 km, are the historical part of the road system. Via Pietro Bonanno is 9 km long and was named after the mayor who promoted its construction. It was designed at the end of the 19$^{th}$ century by the engineer Giuseppe Damiani Almeyda, who started construction in 1903 (Fundarò 1974; Barbera 2008), though it proceeded extremely slowly. After Almeyda's death in 1911, management was assigned to the engineer Carlo De Stefani who completed the work in 1924 (Bonanno 2002).

Due to the rugged morphology of the area, it was necessary to carry out large excavations in order to adapt the rocky terrain to the planned road layout. To level the road cross section, it was necessary to cut the rock and raise the lower part of the slopes using substantial masonry retaining walls along the entire route.

The second part of the road – via Monte Ercta – was built from Gabriele Ascione's design. The excavation works began in 1949, and the construction work was initiated in July 1952, lasting five years. The road was made following the same construction methods as the first part. However, being on the northwestern part of the mountain where the slopes are steeper, it was necessary to build even higher retaining walls, especially in the tight curves above Mondello.

At the same time, the area was reforested with non-native species, especially conifers from the genus *Pinus* (*P. halepensis*, *P. pinea*, etc.) and *Cupressus* (*C. sempervirens*, *C. arizonica*, etc.), as well as broad-leaved trees of the genus *Eucalyptus* (*E. camaldulensis*, *E. globulus*, *E. gomphocephala*, etc.) and other species (*Robinia pseudacacia*, *Ailanthus altissima*, etc.).

In some cases, reforestation influenced the vegetation colonizing the base of the retaining walls by creating shady conditions. In the period between 1927 and 1933, other exotic species were also introduced into the area, such as *Agave americana*, *A. sisalana*, *Opuntia ficus-indica*, and *O. maxima*, which spontaneously spread between the escarpments and the reforested parts, sometimes forming hedges along the road margins, especially on the xeric slopes facing south/southwest, such as near Castello Utveggio.

## Habitats of the roadway structures

The ecological conditions of the anthropogenic micro-habitats created by the construction of the road system reflect the adaptive specialization of the species and plant communities that have settled in them. The studied plant communities were distributed in relation to the following drivers: a) topographical characteristics of the surfaces (horizontal on the road margins, more or less vertical on the walls and rock walls); b) nature of the substrate (stone walls with mortar, asphalt, rocky outcroppings), which generally presents soil poverty, alkaline pH (given the nature of the lithic materials), a lack of nutrients, poor humidity; c) various climatic stresses (e.g., daily and annual temperature ranges, etc.).

Figure 2 shows a cross-section of the roadway on Monte Pellegrino with the different habitats within which the vegetation surveys were carried out. Specifically, these were masonry retaining walls, downhill-side road margins (parapets/guardwalls), uphill-side road margins, artificial rock cuts. For each of the habitats presented in the figure, the main structural and ecological characteristics are defined below, also in relation to the eco-morphological and physiological characteristics of the species and coenoses located there.

1) *Retaining walls* – These continuously delimit the downhill side of the entire road route, with a height ranging from a few meters up to about 20 m (along the hairpin bends near Mondello). They are made of stone blocks cemented with mortar, built with a (a) base plinth, (b) sloping face, (c) and vertical face. Here lithophilous species,

whose roots penetrate the cracks and cavities between the stone blocks, have different settling difficulties, depending on the topographical location (Lisci and Pacini 1993a, 1993b). Cavities at ground level in the base plinth allow the establishment of numerous species, facilitated by the rainwater that flows down the walls, favoring the accumulation of nutrients and moisture needed by plants. Cavities on the sloping faces of the walls also facilitate the germination of seeds thanks to the rainwater that runs down the walls. Cavities on the vertical faces, instead, present greater settling difficulties – in particular on the higher parts and on homogeneous material – given the lower availability of water and nutrients.

2) *Masonry guardwalls (downhill side of the road)* – Here vegetation finds space in two different types of cavities in which accumulations of soil and humidity are generated. They are respectively located: a) on the upper surface of the guardwalls, following the crumbling of the materials due to the weather; b) at the base of the guardwall, at the interface between two types of construction materials (both inside and outside the road surface) which generates a certain water availability in the interstices.

3) *Road margins (uphill side)* – This habitat is located beyond the rainwater collection canals which have more nitrophilic and cooler ecological characteristics than the previous habitat. In fact, vegetation finds more favorable conditions here as there is more shade as well as a greater supply of nutrients and humidity thanks to the rainwater that flows down the slopes and walls above.

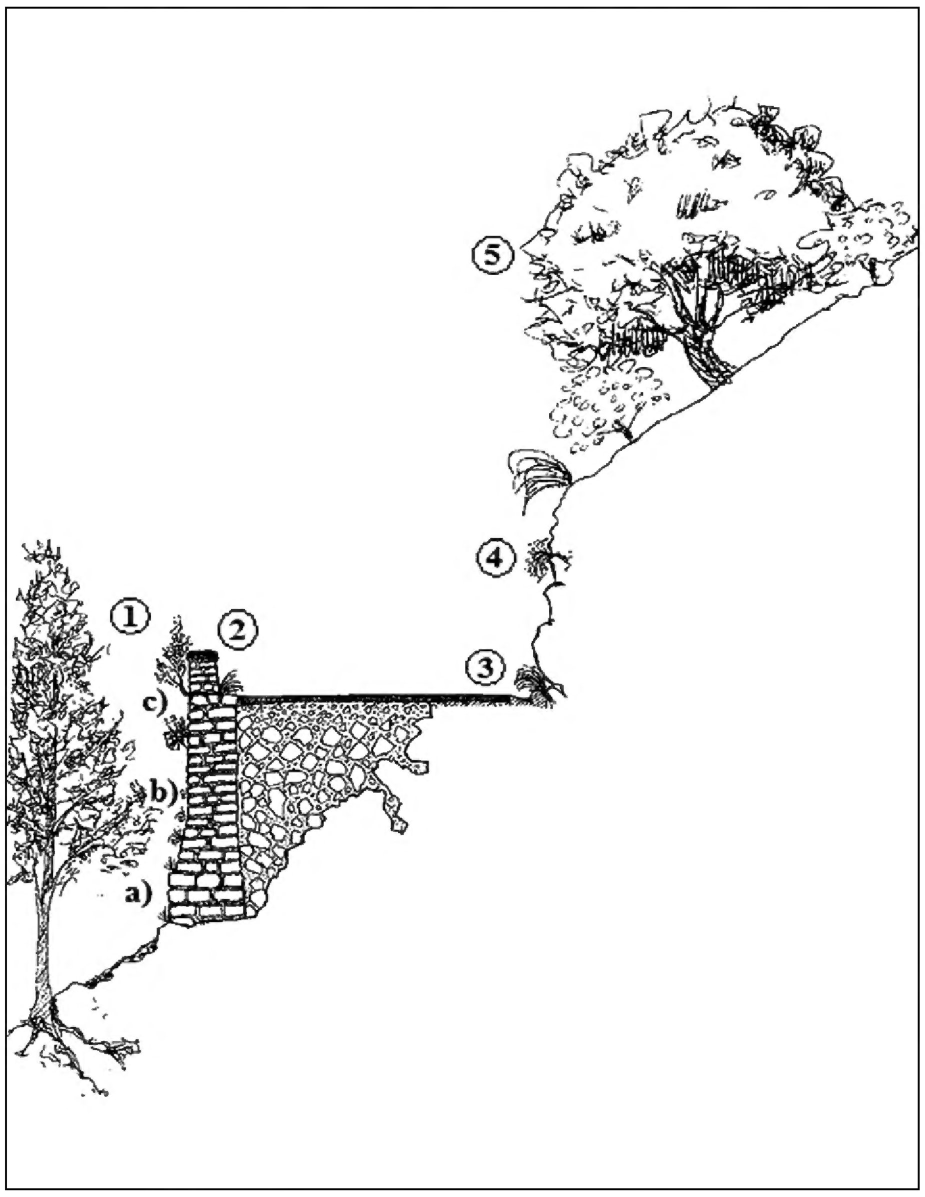


**Figure 2.** Cross-section of the habitat of the Monte Pellegrino road system: 1) retaining wall (a – base plinth; b – sloping face; c – vertical face); 2) downhill-side road margin (masonry guardwalls or parapets); 3) uphill-side road margin; 4) rock cut slopes, 5) natural slope.

4) *Rock cut slopes* – These delimit the uphill part of the road margins and were created by excavating the limestone substrate. They are up to about 15 meters high (on some curves on the Mondello side), giving space to typically rocky communities that develop along the rock walls, according to ecological gradients that can be attributed to purely natural environments. In the upper part, they are true chasmophytic communities dominated by species of the *Asplenietea trichomanis* class, replaced towards the base of the walls by elements attributable to the *Parietarietea judaicae* class.

5) *Natural slopes* – This habitat, completely unrelated to the road profile, is colonized by phytocenotic vegetation linked to the different vegetation series that characterize the Monte Pellegrino promontory (Gianguzzi et al. 1996), not examined in this work.

## Vegetation sampling and data analysis

The vegetation was studied according to the phytosociological method (Braun-Blanquet 1964), as later modified by other authors (e.g., Rivas-Martínez 2005; Biondi 2011; Guarino et al. 2018). Species identifications were made using Pignatti (1982) and Pignatti et al. (2017-2018). Taxonomic nomenclature follows "Flora d'Italia" (Pignatti et al. 2017-2018), with the exception of *Pennisetum setaceum*, which follows the online database "The Plant List" (2013). The life forms and chorotypes follow Pignatti (1982).

The syntaxonomical nomenclature follows the "International Code of Phytosociological Nomenclature" (Theurillat et al. 2020). For the definition of the syntaxa, the "Vegetation Prodrome of Italy" (Biondi et al. 2014) was followed (see the specific interactive site: http://www.prodromo-vegetazione-italia.org/), with reference to the Vegetation Prodrome of Europe (Mucina et al. 2016) for the classes *Cymbalario-Parietarietea diffusae*, *Stipo-Trachynietea distachyae* and the order *Elytrigio repentis-Dittrichietalia viscosae*.

The survey, carried out between 2016 and 2019, was based on stratified random sampling. The study area was divided into different homogeneous ecological contexts based on both construction typology (masonry retaining wall, guardwall, uphill-side road margin, artificial rock cut slope) and exposition (north, west/southwest), and random sampling was conducted within each of these habitats (Michalcová et al. 2011). Plot size was determined as minimum area (*sensu* Braun-Blanquet 1964) and ranged between 5 and 50 m$^2$ in the different vegetation types. The number of relevés was defined on the basis of the micro-habitat's surface area. In the case of some groupments with a very small range on homogeneous surfaces, only 2-4 relevés were done.

To evaluate the distribution pattern of the habitats studied in terms of their specific composition, we used detrended correspondence analysis (DCA; Hill and Gauch

1980) using the RStudio (Version 1.1.463) free software and some functions of the vegan package (Oksanen 2015). The choice of this ordination method was confirmed by the measure of the so-called turnover (or SD units) of DCA, which corresponds to the length of its first ordination axes. Moreover, turnover represents a measure of a community's beta diversity. According to Lepš and Šmilauer (2003), it is preferable to use a unimodal method like DCA for values of turnover units greater than 3.7.

Similarity among different phytocoenoses was evaluated using the "Jaccard Index" (Jaccard 1908). Nestedness was calculated as the average co-occurrence of species, the 'a' component of the "Jaccard Index" (Tsakalos et al. 2018).

The life form analysis of the data in the phytosociological table was made by establishing: the percentage distribution of presence in the species list (flora); the percentage distribution of presence in the relevés (frequency), the percentage distribution of the coverage value in the relevés (cover).

# Results

## Communities on masonry retaining walls

**Cl.:** *CYMBALARIO-PARIETARIETEA DIFFUSAE* Oberd. 1969
Perennial vegetation with hemicryptophytes, nitrophilous and synanthropic, chasmo-comophytic, found on rocky walls and cliffs.

**Ord.:** *TORTULO-CYMBALARIETALIA* Segal 1969
Chasmo-nitrophilous and thermophilous vegetation of built-up areas of the Mediterranean and Atlantic, mild winter to subcontinental regions of temperate Europe, the Middle East, and North Africa.

**All.:** *GALIO VALANTIAE-PARIETARION JUDAICAE* Rivas-Mart. ex O. de Bolòs 1967
Thermomediterranean chasmophytic vegetation of limestone walls of the Iberian Peninsula and the western Tyrrhenian archipelago.

1) *CREPIDO BURSIFOLIAE-PARIETARIETUM JUDAICAE* ass. nov.

***Phytosociological data:*** Table 1.

***Holotypus:*** Rel. 6, Table 1.

***Diagnostic species:*** *Parietaria judaica* (dom.), *Mercurialis annua*, *Oxalis pes-caprae*, *Crepis bursifolia*, *Erigeron bonariensis*.

***Floristic-syntaxonomical notes***: Based on the interpretation of various authors (Bartolo and Brullo 1986; Brullo and Guarino 2002), similar characteristics of wall vegetation have been attributed to the *Oxalido corniculatae-Parietarietum judaicae* association (Br.-Bl. 1952) Segal 1969 [= *Parietarietum judaicae* (Arènes 1928) Oberd. 1977]. This syntaxon has been indicated for different areas of the Mediterranean region (Braun-Blanquet and Tüxen). 1952; de Bolós 1967; Rivas-Martínez 1960, 1969; Horvatić 1963; Bartolo and Brullo 1986; Oberdorfer 1977; Brullo and Guarino 1998, 2002; Brullo et al. 2020) as corresponding to the concept of "phytocoenon". In fact, *Oxalis corniculata* – one of the species that gives the name to the association – is a plant linked to trampled environments (Brullo and Guarino 2002). Therefore, we think that *Oxalido corniculatae-Parietarietum judaicae* should be subdivided into multiple geographic synvariants ("races géographiques") with more limited distribution. This is the case for the two associations proposed here in which, in their typical combinations, high-frequency local differential species were identified, though transgressive from the contiguous phytocoenoses.

***Description:*** It is a hemicryptophytic, sciophilous-nitrophilous, paucispecific formation clearly dominated by *Parietaria judaica*, located on the lower part of walls. It tends to form a more or less continuous and lush belt of vegetation 40-60 (80) cm tall, that normally has coverage between 75-100% with a minimum area of 6-8 $m^2$. The phytocoenosis is subjected to high levels of eutrophication that occurs in wall cracks and interstices between materials (rocks, mortar, concrete, soil, etc.) of different chemical composition. Here, small accumulations of well-humidified and nitrified soil are created from the flow of rainwater on the wall, as well as from the contributions of internal circulation within the wall. Other associated species can be frequent but with low coverage values, some of which have their vegetative optimum in the winter-spring period (e.g., *Oxalis pes-caprae*) while others have it in the spring-summer period (es. *Erigeron bonariensis*, *Crepis bursifolia*, *Mercurialis annua*, etc.). In particular, *Oxalis pes-caprae*, a South-African species in expansion in the Mediterranean area, is an element of the *Stellarietea mediae* class; *Mercurialis annua* is a paleotemperate species, typical of manured fields and belonging to the *Stellarietea mediae* class; *Erigeron bonariensis* is native to tropical America and has almost become a cosmopolite species belonging to the *Chenopodion* (*Sisymbrietalia*, *Stellarietea mediae*) alliance; *Crepis bursifolia* is an endemic Italian species that is rather widespread in the Tyrrhenian area, typical of pavements, trampled environments, and road margins, and is also an element of the T*risetario-Crepidetum bursifoliae* association (*Polygono-Poetea annuae*).

***Syndynamism:*** This phytocoenosis plays a pioneering role at the base of masonry and rock walls and takes part in the shady-mesic geosigmetum (north-northwestern-facing slope) of the road system in question (Fig. 3A). It is rarer on the southern part of Monte Pellegrino where it is located on the north-facing walls of via Bonanno (Fig. 4A).

The association is in contact with: (a) the vegetation of horizontal surfaces, such as trampled areas (cl. *Polygono-Poetea annuae*), flower beds, cultivated areas (cl. Stellarietea mediae), as well as serial aspects of the slope vegetation of *Rhamno-Querco ilicis* sigmetum; (b) vegetation on the tops of walls, dominated by Parietaria judaica (*Athamanto siculae-Parietarietum judaicae* ass. nov.), *Hypochaeris laevigata* (*Helichryso panormitanae-Hypo-*

**Table 1.** *Crepido bursifoliae-Parietarietum judaicae* ass. nov.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5 | 6* | 7 | 8 | 9 | 10 | 11 | 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 20 | 20 | 20 | 25 | 30 | 50 | 80 | 330 | 340 | 420 | 425 | 430 | |
| Slope (°) | 5 | 3 | 5 | 5 | 5 | 2 | 2 | 5 | 4 | 2 | 5 | 5 | |
| Aspect | N | N | NE | E | E | N | NE | W | NW | NW | NW | NW | |
| Area (m²) | 8 | 6 | 6 | 5 | 4 | 8 | 6 | 10 | 5 | 8 | 8 | 6 | |
| Total cover (%) | 100 | 90 | 100 | 100 | 100 | 90 | 100 | 85 | 95 | 100 | 100 | 100 | |
| Average height (cm) | 50 | 50 | 45 | 45 | 45 | 40 | 50 | 40 | 50 | 45 | 45 | 50 | |
| Species per relevé | 8 | 9 | 8 | 7 | 6 | 12 | 14 | 8 | 9 | 13 | 11 | 9 | Presence |
| **Characteristic and differential species of association** | | | | | | | | | | | | | |
| *Parietaria judaica* L. | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 12 |
| *Mercurialis annua* L. | . | . | + | . | + | . | + | + | . | 2 | 1 | + | 7 |
| *Crepis bursifolia* L. | 1 | + | + | + | . | + | + | . | . | + | + | + | 9 |
| *Erigeron bonariensis* L. | . | + | + | + | + | 1 | + | . | + | . | . | . | 7 |
| *Oxalis pes caprae* L. | . | . | + | . | . | + | . | + | 1 | . | + | . | 5 |
| **Char. of the alliance** | | | | | | | | | | | | | |
| *Antirrhinum siculum* Mill. | + | 1 | 1 | + | + | + | 1 | 1 | 1 | . | . | . | 9 |
| *Hyoscyamus albus* L. | . | + | . | 2 | 1 | . | . | . | . | . | . | . | 3 |
| *Reichardia picroides* (L.) Roth | . | . | . | . | . | . | . | . | + | . | + | . | 2 |
| **Char. of the order and class** | | | | | | | | | | | | | |
| *Sonchus tenerrimus* L. | 2 | + | + | . | 2 | + | + | . | + | + | + | 1 | 10 |
| *Umbilicus horizontalis* (Guss.) DC. | . | . | . | . | . | . | + | . | + | + | + | + | 5 |
| *Ceterach officinarum* Willd. | . | . | . | . | . | . | . | + | + | . | . | . | 2 |
| *Cymbalaria muralis* G.Gaertn., B.Mey. et Scherb. | + | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Sedum dasyphyllum* L. subsp. *dasyphyllum* | . | . | . | . | . | . | . | . | . | + | . | . | 1 |
| **Other species** | | | | | | | | | | | | | |
| *Piptatherum miliaceum* (L.) Coss. | 1 | . | + | . | . | 1 | . | . | . | . | . | . | 3 |
| *Poa annua* L. | . | 1 | . | . | . | 1 | + | . | . | . | . | . | 3 |
| *Hordeum murinum* subsp. *leporinum* (Link) Arcang. | . | . | . | . | . | 1 | . | . | . | + | + | . | 3 |
| *Dactylis glomerata* L. | . | . | . | . | . | . | + | . | . | + | . | + | 3 |
| *Briza maxima* L. | . | . | . | . | . | . | + | . | . | + | . | + | 3 |
| *Lagurus ovatus* L. subsp. *ovatus* | . | . | . | . | . | . | + | . | . | . | + | + | 3 |
| *Hirschfeldia incana* (L.) Lagr.-Foss. subsp. *incana* | + | . | . | . | . | + | . | . | . | . | . | . | 2 |
| *Polycarpon tetraphyllum* (L.) L. | . | . | . | . | . | + | 1 | . | . | . | . | . | 2 |
| *Campanula erinus* L. | . | . | . | . | . | . | . | + | + | . | . | . | 2 |
| *Solanum villosum* Mill. | . | . | . | . | . | . | 1 | . | . | . | . | 1 | 2 |
| *Scrophularia peregrina* L. | 1 | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Polygonum aviculare* L. | . | + | . | . | . | . | . | . | . | . | . | . | 1 |
| *Boerhavia repens* L. | . | + | . | . | . | . | . | . | . | . | . | . | 1 |
| *Sisymbrium officinale* (L.) Scop. | . | . | . | 2 | . | . | . | . | . | . | . | . | 1 |
| *Dysphania ambrosioides* (L.) Mosyakin et Clemants | . | . | . | 1 | . | . | . | . | . | . | . | . | 1 |
| *Cynodon dactylon* (L.) Pers. | . | . | . | . | . | 1 | . | . | . | . | . | . | 1 |
| *Ailanthus altissima* (Mill.) Swingle | . | . | . | . | . | . | + | . | . | . | . | . | 1 |
| *Allium subhirsutum* L. | . | . | . | . | . | . | . | 1 | . | . | . | . | 1 |
| *Avena barbata* Pott ex Link | . | . | . | . | . | . | . | + | . | . | . | . | 1 |
| *Polypodium cambricum* L. | . | . | . | . | . | . | . | . | . | 1 | . | . | 1 |
| *Vicia villosa* subsp. *varia* (Host) Corb. | . | . | . | . | . | . | . | . | . | + | . | . | 1 |
| *Lolium perenne* L. | . | . | . | . | . | . | . | . | . | + | . | . | 1 |
| *Clinopodium nepeta* (L.) Kuntze | . | . | . | . | . | . | . | . | . | + | . | . | 1 |
| *Acanthus mollis* L. subsp. *mollis* | . | . | . | . | . | . | . | . | . | . | + | . | 1 |
| *Bromus sterilis* L. | . | . | . | . | . | . | . | . | . | . | + | . | 1 |

*chaeridetum laevigatae* ass. nov.), and *Lomelosia cretica* (*Scabioso-Centauretum ucriae*).

***Synchorology:*** The association, quite common in the study area, probably has a wider distribution in Sicily and the Tyrrhenian area.

2) *ATHAMANTO SICULAE-PARIETARIETUM JUDAICAE* ass. nov.

***Phytosociological data:*** Table 2.

***Holotypus:*** Rel. 3, Table 2.

***Diagnostic species:*** *Parietaria judaica* (dom.), *Athamanta sicula*, *Antirrhinum siculum*, *Campanula erinus*.

***Description:*** It is a hemicryptophytic, sciophilous-nitrophilous, paucispecific formation, clearly dominated by *Parietaria judaica*, typical of cool and shady upper parts of walls (Fig. 3B). The association prefers the parts of walls with less eutrophication which mainly benefit from humidity and humus generated by percolation inside the embankment. Very few other species of *Parietarietea* (*Ceterach officinarum*, *Antirrhinum siculum*, etc.)

**Table 2.** *Athamanto siculae-Parietarietum judaicae* ass. nov.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Relevé (n°) | 1 | 2 | 3* | 4 | 5 | 6 | |
| Altitude (m) | 150 | 170 | 410 | 410 | 417 | 420 | |
| Slope (°) | 95 | 95 | 95 | 70 | 70 | 80 | |
| Aspect | SE | E | N | N | N | N | |
| Area ($m^2$) | 8 | 6 | 6 | 10 | 8 | 10 | |
| Total cover (%) | 60 | 65 | 70 | 70 | 70 | 80 | |
| Average height (cm) | 30 | 35 | 40 | 45 | 40 | 40 | |
| Species per relevé | 11 | 14 | 9 | 10 | 8 | 8 | Presence |
| **Characteristic and differential species of association** | | | | | | | |
| *Parietaria judaica* L. | 3 | 3 | 3 | 3 | 3 | 2 | 6 |
| *Athamanta sicula* L. | . | 1 | + | 1 | + | 1 | 5 |
| *Campanula erinus* L. | 2 | 1 | 1 | + | + | + | 6 |
| **Char. of the alliance** | | | | | | | |
| *Antirrhinum siculum* Mill. | 1 | 1 | . | + | . | + | 4 |
| *Hyoseris radiata* L. | 1 | 1 | + | . | + | + | 5 |
| **Char. of the order and class** | | | | | | | |
| *Sonchus tenerrimus* L. | + | + | 1 | . | . | + | 4 |
| *Umbilicus horizontalis* (Guss.) DC. | + | + | . | 1 | + | + | 5 |
| *Hypochaeris laevigata* (L.) Ces., Pass. et Gibelli | . | + | 1 | + | 1 | . | 4 |
| *Ceterach officinarum* Willd. | + | 1 | . | + | + | . | 4 |
| *Cymbalaria muralis* G.Gaertn., B.Mey. et Scherb. | . | . | + | . | . | . | 1 |
| **Other species** | | | | | | | |
| *Lagurus ovatus* L. subsp. *ovatus* | + | . | + | + | . | . | 3 |
| *Pinus halepensis* Mill. | + | + | . | . | . | . | 2 |
| *Trachynia distachya* (L.) Link | + | + | . | . | . | . | 2 |
| *Pennisetum setaceum* (Forssk.) Chiov. | + | + | . | . | . | . | 2 |
| *Asphodelus ramosus* L. subsp. *ramosus* | . | + | . | . | . | . | 1 |
| *Allium subhirsutum* L. | . | . | . | 1 | . | . | 1 |
| Musci | . | 1 | 1 | 1 | 2 | 1 | 5 |

are associated, except for *Athamanta sicula* (an endemic chasmophyte of the class *Asplenietea trichomanis*) and *Campanula erinus* (a therophyte species of the alliance *Valantio-Galion muralis*, order *Geranio-Cardaminetalia*), all with very sporadic presence. The elements of trampled areas, ruderal areas, and road margins (classes *Polygono-Poetea annuae*, *Stellarietea mediae* and alliance *Bromo-Oryzopsion*) that characterize the vegetation developing at the bases of walls (described above), are missing.

***Syndynamism:*** The association plays a pioneer role in the colonization of walls and takes part in the shady-mesic geosigmetum of the Monte Pellegrino road system where it is north-facing.

It establishes the following contacts: a) *Crepido bursifoliae-Parietarietum judaicae* ass. nov. (lower parts of the walls); b) *Diantho siculae-Helichrysetum panormitani* ass. nov. (exposed parts of older, higher walls).

***Synchorology:*** The phytocoenosis is frequent in the study area and probably has a wider distribution in Sicily and the Tyrrhenian area.

3) *HELICHRYSO PANORMITANAE-HYPOCHAERIDETUM LAEVIGATAE* ass. nov.

***Phytosociological data:*** Table 3.

***Holotypus:*** Rel. 3, Table 3.

***Diagnostic species:*** *Hypochaeris laevigata* (dom.), *Helichrysum panormitanum*, *Antirrhinum siculum*.

***Description:*** It is a chamaephytic-hemicryptophytic, sciophilous-nitrophilous formation dominated by *Hypochaeris laevigata* and associated, among other species, with the endemic *Helichrysum panormitanum* and *Antirrhinum siculum*, which are differentials of the phytocoenosis (Fig. 3C). In its typical aspect, the association is widespread mainly in the first 4-6 meters of rock and masonry walls, in cool and shaded areas of north-facing surfaces.

***Syndynamism:*** The association plays a pioneer role in the colonization of walls and takes part in the shady-mesic geosigmetum of the road system. It establishes catenal contacts with the following coenoses: a) *Athamanto siculae-Parietarietum judaicae* ass. nov. (middle part of walls); b) *Centranthetum rubri* (less exposed vertical parts of walls); c) *Diantho siculae-Helichrysetum panormitani* ass. nov. (exposed parts of old higher walls).

***Synchorology:*** The association was observed along the northern slope of Monte Pellegrino, but presumably it is present in other similar contexts of the mountains of the Palermo area.

4) *CENTRANTHETUM RUBRI* Oberd. 1969

***Phytosociological data:*** Table 4.

***Lectotypus:*** Rel. 16, Table 1, Oberdorfer (1969).

***Diagnostic species:*** *Centranthus ruber* (dom.).

***Description:*** It is a chasmo-nitrophilous heliophilous coenosis dominated by *Centranthus ruber* and located in

**Table 3.** *Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov.

| Relevé (n°) | 1 | 2 | 3* | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|---|
| Altitude (m) | 90 | 95 | 100 | 90 | 130 | 135 | |
| Slope (°) | 90 | 90 | 90 | 90 | 90 | 90 | |
| Aspect | N | N/NE | N | N | N/NW | N | |
| Area (m²) | 10 | 20 | 8 | 20 | 10 | 20 | |
| Total cover (%) | 30 | 40 | 35 | 30 | 30 | 30 | |
| Average height (cm) | 30 | 30 | 35 | 20 | 30 | 35 | |
| Species per relevé | 19 | 22 | 16 | 13 | 19 | 17 | Presence |
| **Characteristic and differential species of association** | | | | | | | |
| *Hypochaeris laevigata* (L.) Ces., Pass. et Gibelli | 3 | 3 | 3 | 2 | 2 | 3 | 6 |
| *Helichrysum panormitanum* Guss. subsp. *panormitanum* | + | 1 | 1 | . | 1 | 1 | 5 |
| *Antirrhinum siculum* Mill. | + | + | + | . | + | . | 4 |
| **Char. of the alliance, order and class** | | | | | | | |
| *Parietaria judaica* L. | 2 | 1 | 1 | 1 | 1 | 1 | 6 |
| *Centranthus ruber* (L.) DC. | + | 1 | + | 1 | + | + | 6 |
| *Umbilicus horizontalis* (Guss.) DC. | 1 | + | + | . | + | + | 5 |
| *Anogramma leptophylla* (L.) Link | + | + | + | + | . | + | 5 |
| *Ceterach officinarum* Willd. | + | + | . | . | + | . | 3 |
| *Hyoseris radiata* L. | . | . | + | . | . | + | 2 |
| *Reichardia picroides* (L.) Roth | . | . | . | . | + | . | 1 |
| **Transgressive species of the class *Asplenietea trichomanis*** | | | | | | | |
| *Polypodium cambricum* L. | 1 | 1 | . | + | + | 1 | 5 |
| *Dianthus rupicola* Biv. | . | 1 | 1 | . | . | 1 | 3 |
| *Iberis semperflorens* L. | . | 1 | . | . | + | 1 | 3 |
| *Cymbalaria pubescens* (C.Presl) Cufod. | . | . | 1 | . | 1 | . | 2 |
| *Athamanta sicula* L. | . | 1 | . | . | . | . | 1 |
| **Transgr. of the class *Quercetea ilicis*** | | | | | | | **0** |
| *Allium subhirsutum* L. | 1 | 1 | 1 | . | + | 1 | 5 |
| *Pistacia terebinthus* L. subsp. *terebinthus* | + | 1 | 1 | . | . | . | 3 |
| *Rhamnus alaternus* L. subsp. *alaternus* | 1 | 1 | 1 | . | . | . | 3 |
| *Prasium majus* L. | 1 | . | . | . | + | 1 | 3 |
| *Artemisia arborescens* L. | + | . | + | . | . | . | 2 |
| *Arisarum vulgare* O.Targ.Tozz. | + | . | . | . | 1 | . | 2 |
| *Ampelodesmos mauritanicus* (Poir.) T.Durand et Schinz | . | 1 | . | . | . | 1 | 2 |
| *Selaginella denticulata* (L.) Spring | . | . | . | 1 | + | . | 2 |
| *Euphorbia dendroides* L. | . | . | . | 1 | . | . | 1 |
| **Other species** | | | | | | | |
| *Campanula erinus* L. | 1 | + | 1 | 1 | . | 1 | 5 |
| *Theligonum cynocrambe* L. | 1 | 1 | 1 | + | + | + | 6 |
| *Mercurialis annua* L. | 1 | + | . | . | . | + | 3 |
| *Carlina sicula* Ten. | + | . | . | . | . | 1 | 2 |
| *Galium murale* (L.) All. | . | 1 | . | 1 | . | . | 2 |
| *Oxalis pes caprae* L. | . | 1 | . | . | 1 | . | 2 |
| *Hypochaeris achyrophorus* L. | . | . | . | + | + | . | 2 |
| *Valantia muralis* L. | . | 1 | . | . | . | . | 1 |
| *Geranium lucidum* L. | . | . | . | + | . | . | 1 |
| *Stellaria neglecta* Weihe subsp. *neglecta* | . | . | . | + | . | . | 1 |
| *Micromeria fruticulosa* (Bertol.) Šilić (Bertol.) Guinea | . | . | . | . | + | . | 1 |

the upper parts of less exposed walls and other masonry structures. The association prefers cooler habitats where it benefits from a certain amount of edaphic humidity due to water percolation inside the embankment.

***Syndynamism:*** In the local area, this phytocoenosis belongs to the shady-mesic geosigmetum of the north-facing slope of the promontory located, in particular, on the more sheltered walls of the hairpin bends of Contrada Allaura. The association establishes catenal contacts with the following coenoses: a) *Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov. (near the base of old walls shaded by tree foliage); b) *Diantho siculae-Helichrysetum panormitani* ass. nov. (exposed upper parts of old walls, above 6-8 m); c) groupment with *Rhamnus alaternus* and *Pistacia terebinthus* (upper parts of walls at 4-6 m).

***Synchorology:*** The association is spread across the Mediterranean area in the thermomediterranean and lower mesomediterranean bioclimatic belts, and is present in Sicily to some extent (Brullo and Guarino 2002). It is not frequent in the study areas, where it is only located on the northern slopes.

**Table 4.** *Centranthetum rubri* Oberd. 1969.

| | | | | | |
|---|---|---|---|---|---|
| Relevé (n°) | 1 | 2 | 3 | 4 | |
| Altitude (m) | 90 | 95 | 90 | 95 | |
| Slope (°) | 90 | 90 | 90 | 90 | |
| Aspect | N | N/NE | N | N/NE | |
| Area (m²) | 20 | 20 | 20 | 20 | |
| Total cover (%) | 50 | 45 | 50 | 45 | |
| Average height (cm) | 40 | 45 | 40 | 45 | |
| Species per relevé | 12 | 10 | 14 | 12 | Presence |
| **Guide species** | | | | | |
| *Centranthus ruber* (L.) DC. | 3 | 3 | 3 | 3 | 5 |
| **Char. of the class *Parietarietea judaicae*** | | | | | |
| *Hypochaeris laevigata* (L.) Ces., Pass. et Gibelli | 1 | 2 | 1 | 1 | 4 |
| *Parietaria judaica* L. | 1 | + | 1 | 1 | 4 |
| *Ceterach officinarum* Willd. | + | + | + | + | 4 |
| *Antirrhinum siculum* Mill. | 1 | . | 1 | + | 3 |
| *Umbilicus horizontalis* (Guss.) DC. | . | + | + | + | 3 |
| **Transgr. of the class *Asplenietea trichomanis*** | | | | | |
| *Dianthus rupicola* Biv. | . | 1 | + | 1 | 3 |
| *Helichrysum panormitanum* Guss. | . | 1 | . | 1 | 2 |
| **Other species** | | | | | |
| *Campanula erinus* L. | 1 | + | 1 | + | 4 |
| *Galium murale* (L.) All. | 2 | 1 | 2 | 2 | 4 |
| *Allium subhirsutum* L. | 1 | 1 | + | 1 | 4 |
| *Hypochaeris achyrophorus* L. | + | . | + | + | 3 |
| *Euphorbia dendroides* L. | 1 | . | 1 | . | 2 |
| *Arisarum vulgare* O.Targ.Tozz. | + | . | + | . | 2 |
| *Selaginella denticulata* (L.) Spring | + | . | + | . | 2 |

5) *ANTIRRHINETUM SICULI* Bartolo & Brullo 1986

***Phytosociological data:*** Table 5.

***Holotypus:*** Rel. 2, Table 3, Bartolo & Brullo (1986).

***Diagnostic species:*** *Antirrhinum siculum* (dom.).

***Description:*** It is a chasmo-nitrophilous paucispecific formation with an open structure, heliophilous and thermo-xerophilous, dominated by *Antirrhinum siculum* (Fig. 4B), an endemic species of Sicily and southern Italy, adapted to growing on masonry structures. The phytocoenosis mainly colonizes the upper parts of xeric stone, where it is located in poorly humified cracks.

***Syndynamism:*** The phytocoenosis belongs to the more xeric geosigmetum of the study areas, where it is found mostly on the southern and western slopes. It comes into catenal contact with the following associations: a) *Olopto miliacei-Pennisetetum setacei* ass. nov. (both at the base of the walls and on the upper parts, in particular on guardwalls); b) *Capparidetum rupestris* (in the upper parts of some walls); *Rhamno alaterni-Euphorbietum dendroidis* Géhu and Biondi 1997 *artemisietosum arborescentis* subass. nov. (guardwalls of sunny and sheltered walls).

***Synchorology:*** The association is endemic in the southern parts of the Italian Peninsula (Brullo et al. 2001; Brullo and Guarino 2002), Sicily (Bartolo and Brullo 1986; Gianguzzi 2007), and Malta (Brullo et al. 2020).

**All.**: *ARTEMISIO ARBORESCENTIS-CAPPARIDION SPINOSAE* Biondi, Blasi et Galdenzi in Biondi et al. 2014

Thermomediterranean chasmophytic vegetation of limestone walls of the Apennine Peninsula, Corsica, Sardinia, Sicily, and Malta.

6) *CAPPARIDETUM RUPESTRIS* O. Bolòs et Molinier 1958

***Lectotypus:*** Rel. 1, Table18, Bolòs & Molinier (1958).

***Phytosociological data:*** Table 6.

***Diagnostic species:*** *Capparis spinosa* (dom.).

***Description:*** It is a chasmo-nitrophilous paucispecific formation with an open structure, heliophilous and xerophilous, dominated by large bushes of *Capparis spinosa*, typical of calcareous rocks and masonry walls (Fig. 4C). The phytocoenosis occupies the upper parts of old masonry walls and rock walls where it is located in sunny and xeric positions which are more or less sheltered and nitrified. In the road system investigated, it has mostly colonized the artificial rock slopes created by cutting into the limestone, in particular in the upper parts, over 4-5 m high on south-facing aspects.

***Syndynamism:*** The phytocoenosis is a mature, permanent vegetation that grows on the most xeric geosigmetum of walls, located mostly on the southern slopes of the promontory. Here, it establishes catenal contacts with the following coenoses: a) *Olopto miliacei-Pennisetetum setacei* ass. nov. (both at the base of the walls and on the upper parts, in particular on the guardwalls); b) *Antirrhinetum siculi* (on the upper parts of some walls); c) *Rhamno alaterni-Euphorbietum dendroidis* Géhu & Biondi 1997 *arte-*

**Table 5.** *Antirrhinetum siculi* Bartolo & Brullo 1986.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5 | Presence |
|---|---|---|---|---|---|---|
| Altitude (m) | 570 | 550 | 350 | 330 | 550 | |
| Slope (°) | 90 | 90 | 90 | 90 | 90 | |
| Aspect | S | SW | S | W | SW | |
| Area (m²) | 5 | 5 | 4 | 5 | 5 | |
| Total cover (%) | 45 | 50 | 50 | 50 | 45 | |
| Average height (cm) | 20 | 20 | 20 | 20 | 20 | |
| Species per relevé | 18 | 14 | 15 | 12 | 15 | |
| **Guide species** | | | | | | |
| *Antirrhinum siculum* Mill. | 3 | 2 | 3 | 2 | 2 | 5 |
| **Char. of the alliance, order and class** | | | | | | |
| *Umbilicus horizontalis* (Guss.) DC. | 1 | 1 | + | 1 | 1 | 5 |
| *Ceterach officinarum* Willd. | 1 | . | 1 | 1 | + | 4 |
| **Transgr. of the class *Tuberarietea guttatae*** | | | | | | |
| *Misopates orontium* (L.) Raf. | + | + | + | 1 | + | 5 |
| *Carduus pycnocephalus* L. | 1 | + | 1 | 1 | + | 5 |
| *Hypochaeris achyrophorus* L. | 1 | + | 1 | + | + | 5 |
| *Avena barbata* Pott ex Link | 1 | + | 1 | . | + | 4 |
| *Anisantha fasciculata* (C.Presl) Nevski | + | + | + | . | + | 4 |
| *Campanula erinus* L. | 1 | 1 | . | 1 | 1 | 4 |
| *Lagurus ovatus* L. subsp. *ovatus* | + | + | . | . | + | 3 |
| **Char. of the alliance, order and class** | | | | | | |
| *Phagnalon saxatile* (L.) Cass. | + | 2 | 1 | 1 | 2 | 5 |
| *Pennisetum setaceum* (Forssk.) Chiov. | 1 | 1 | + | 1 | 1 | 5 |
| *Sonchus tenerrimus* L. | 1 | 1 | + | + | 1 | 5 |
| *Theligonum cynocrambe* L. | + | + | 1 | + | + | 5 |
| *Trifolium stellatum* L. | 1 | . | 1 | 1 | . | 3 |
| *Mercurialis annua* L. | 1 | . | 1 | . | . | 2 |
| *Echium parviflorum* Moench | + | . | + | . | . | 2 |
| *Euphorbia dendroides* L. | . | 1 | . | . | 1 | 2 |
| *Asparagus albus* L. | + | . | . | . | . | 1 |

*misietosum arborescentis* subass. nov. (on sunny and sheltered guardwalls).

***Synchorology:*** The association, described by De Bolós and Molinier (1958), is widespread in the Mediterranean area (Brullo and Guarino 2002) and, as reported by several authors, specifically in Sicily (Bartolo and Brullo 1986; Brullo et al. 1993; Gianguzzi 2007) and on the islands of Lampedusa (Bartolo et al. 1990) and Pantelleria (Gianguzzi 1999). In the study areas, it is frequently found along the roads on the slope of Contrada Arenella (Gianguzzi et al. 1996).

**Cl.**: *ASPLENIETEA TRICHOMANIS* (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977
Chasmophytic vegetation of crevices, rocky ledges and faces of rocky cliffs and walls of Europe, North Africa, the Middle East, Arctic archipelagos and Greenland.

**Ord.**: *ASPLENIETALIA GLANDULOSI* Br.-Bl. in Meier & Br.-Bl. 1934
Thermo-mesomediterranean chasmophytic vegetation of sunny calcareous rock faces and crevices of the western Mediterranean.

**All.**: *DIANTHION RUPICOLAE* Brullo & Marcenò 1979
Siculo-Calabrian Tyrrhenian coasts and the islands of Malta.

7) *DIANTHO SICULAE-HELICHRYSETUM PANORMITANI* Gianguzzi ass. nov.

***Phytosociological data:*** Table 7.

***Holotypus:*** Rel. 5, Table 7.

***Diagnostic species:*** *Helichrysum panormitanum* subsp. *panormitanum* (dom.), *Dianthus rupicola*, *Micromeria fruticulosa*, *Antirrhinum siculum*.

***Floristic-syntaxonomical notes:*** *Helichrysum panormitanum* Guss. subsp. *panormitanum* (= *H. rupestre* (Raf.) DC. var. *panormitanum* (Guss.) Lojac.) is an endemic chasmophyte of the coastal capes to the west of Palermo, from Mt. Pellegrino to Castellammare del Golfo (Iamonico et al. 2016), which is linked to rupicolous environments in which it is considered an element of the *Dianthion rupicolae* alliance. The phytocoenosis in question is framed in the latter alliance, given the general physiognomy of vegetation clearly influenced by rupicolous species of the class *Asplenietea*. This is evident, above all, on the oldest walls which provide high and exposed cliff-like habitats.

***Description:*** It is a chasmophilous, paucispecific, heliophilous, and mesophilous formation dominated by *Helichrysum panormitanum* subsp. *panormitanum*, typical of the highest parts of old walls, above 4-6 m. The association is located in sunny and xeric places which are not

**Table 6.** *Capparidetum rupestris* O. Bolòs et Molinier 1958.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|---|
| Altitude (m) | 90 | 92 | 150 | 180 | 6 | 6 | |
| Slope (°) | 85 | 85 | 90 | 90 | 90 | 90 | |
| Aspect | E | E | E | E | N | NE | |
| Area (m²) | 8 | 10 | 15 | 15 | 15 | 15 | |
| Total cover (%) | 60 | 55 | 60 | 50 | 40 | 30 | |
| Average height (cm) | 60 | 50 | 70 | 65 | 60 | 60 | |
| Species per relevé | 11 | 11 | 13 | 13 | 8 | 10 | Presence |
| **Characteristic and differentials species of association** | | | | | | | |
| *Capparis spinosa* L. | 3 | 3 | 3 | 3 | 2 | 2 | 6 |
| **Char. of the class *Parietarietea judaicae*** | | | | | | | |
| *Antirrhinum siculum* Mill. | 1 | 1 | + | 1 | . | + | 5 |
| *Hyoseris radiata* L. | + | + | + | . | + | + | 5 |
| *Parietaria judaica* L. | 1 | 1 | . | + | + | + | 5 |
| *Umbilicus horizontalis* (Guss.) DC. | + | . | . | + | . | + | 3 |
| *Sonchus tenerrimus* L. | . | . | . | + | + | + | 3 |
| *Ceterach officinarum* Willd. | . | + | . | + | . | . | 2 |
| *Hyoscyamus albus* L. | . | . | . | . | 1 | 1 | 2 |
| *Reichardia picroides* (L.) Roth | . | . | + | . | . | . | 1 |
| *Ficus carica* L. | . | + | . | . | . | . | 1 |
| **Transgr. of the class *Asplenietea trichomanis*** | | | | | | | |
| *Helichrysum panormitanum* Guss. | 2 | 1 | 1 | 1 | | | 4 |
| *Dianthus rupicola* Biv. | 1 | 2 | 1 | 1 | | | 4 |
| *Seseli bocconei* Guss. | . | . | + | 1 | | | 2 |
| *Phagnalon saxatile* (L.) Cass. | + | 1 | . | . | | | 2 |
| **Other species** | | | | | | | |
| *Pennisetum setaceum* (Forssk.) Chiov. | 1 | 1 | . | . | + | + | 4 |
| *Micromeria fruticulosa* (Bertol.) Šilić | 1 | . | + | 1 | . | . | 3 |
| *Campanula erinus* L. | 1 | . | . | . | . | + | 2 |
| *Sachys major* (L.) Bartolucci et Peruzzi | . | . | 1 | + | . | . | 2 |
| *Galium cinereum* All. | . | . | + | 1 | . | . | 2 |
| *Euphorbia dendroides* L. | . | . | 1 | + | . | . | 2 |
| *Symphyotrichum squamatum* (Spreng.) G.L.Nesom | . | . | . | . | + | + | 2 |
| *Valantia muralis* L. | . | + | . | . | . | . | 1 |
| *Lomelosia cretica* (L.) Greuter et Burdet | . | . | 1 | . | . | . | 1 |
| *Pinus halepensis* Mill. | . | . | + | . | . | . | 1 |
| *Fumaria capreolata* L. subsp. *capreolata* | . | . | . | . | + | . | 1 |

well nitrified, mainly on the north-facing walls and rarely on natural or artificial rocky cliffs. Species of the class *Parietarietea judaicae* (*Ceterach officinarum*, *Parietaria judaica*, *Antirrhinum siculum*, *Capparis spinosa*), with low coverage values, as well as several elements of the class *Asplenietea trichomanis* (*Dianthus rupicola*, *Lomelosia cretica*, *Matthiola incana* subsp. *rupestris*, *Seseli bocconei*, etc.) are associated with it. The community forms dense vegetation belts due to thick patches of the dominant species covering the cracks between the stone blocks.

***Syndynamism:*** The association is well represented in the shady-mesic geosigmetum of the road stretches located in the north/northwest-facing slopes of the promontory. It establishes contacts with the following phytocoenoses: a) *Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov. (at the base of walls shaded by the crowns of trees); b) *Centranthetum rubri* (at the base of sunny walls); c) *Rhamnus alaternus* and *Pistacia terebinthus* groupment (upper parts of the highest walls).

***Synchorology:*** The phytocoenosis is spread along the entire road system of Monte Pellegrino, especially on the highest and most exposed stretches of the northern and western sides (via Monte Ercta).

## Communities of rock cut slopes

8) *SCABIOSO CRETICAE-CENTAURETUM UCRIAE* Brullo et Marcenò 1979 subass. *TYPICUM*

***Phytosociological data:*** Table 8.

***Holotypus:*** Rel. p. 139, in Brullo et Marcenò (1979).

***Diagnostic species:*** *Lomelosia cretica* (dom.), *Helichrysum panormitanum*, *Euphorbia bivonae* subsp. *bivonae*, *Centaurea panormitana* (= *C. ucriae* Lacaita), *Convolvulus cneorum*, *Dianthus rupicola*, *Seseli bocconei*, *Silene fruticosa*, *Iberis semperflorens*.

***Description:*** It is a chasmophilous, heliophilous, and mesophilous formation, widespread on the upper parts of

**Table 7.** *Diantho rupicolae-Helichrysetum panormitani* Gianguzzi ass. nov.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5* | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Presence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 150 | 110 | 150 | 160 | 186 | 190 | 160 | 170 | 150 | 180 | 330 | 330 | 300 | 300 | 270 | |
| Slope (°) | 90 | 90 | 90 | 85 | 85 | 85 | 90 | 90 | 90 | 90 | 85 | 90 | 85 | 85 | 85 | |
| Aspect | N | N | N | N | NW | NW | E | E | E | E | W | W | SW | SW | W | |
| Area (m²) | 20 | 20 | 20 | 15 | 20 | 15 | 15 | 15 | 15 | 15 | 20 | 12 | 20 | 30 | 20 | |
| Total cover (%) | 55 | 55 | 50 | 55 | 60 | 60 | 50 | 50 | 55 | 60 | 65 | 60 | 60 | 60 | 50 | |
| Average height (cm) | 50 | 50 | 35 | 40 | 40 | 45 | 45 | 40 | 55 | 60 | 50 | 40 | 40 | 40 | 50 | |
| Species per relevé | 20 | 17 | 15 | 15 | 17 | 17 | 19 | 14 | 17 | 14 | 12 | 12 | 16 | 19 | 17 | |
| **Characteristic and differentials species of association** | | | | | | | | | | | | | | | | |
| *Helichrysum panormitanum* Guss. | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 15 |
| *Dianthus rupicola* Biv. | 1 | . | 1 | 1 | 1 | . | 1 | + | 1 | 1 | 1 | + | 1 | 1 | 1 | 13 |
| *Micromeria fruticulosa* (Bertol.) Šilić | 1 | . | + | + | . | . | 1 | 1 | + | 1 | . | + | 1 | 1 | 1 | 11 |
| *Antirrhinum siculum* Mill. | + | + | . | + | + | + | . | . | + | 1 | + | 1 | . | . | . | 9 |
| **Char. of the alliance *Dianthion rupicolae* and class *Asplenietea trichomanis*** | | | | | | | | | | | | | | | | |
| *Lomelosia cretica* (L.) Greuter et Burdet | 1 | + | . | + | 1 | + | 1 | 1 | 1 | + | 1 | + | . | 1 | 1 | 13 |
| *Galium cinereum* All. | + | . | . | 1 | + | 1 | + | + | + | + | . | + | . | + | . | 10 |
| *Seseli bocconei* Guss. | 1 | + | . | . | . | . | + | + | + | 1 | + | . | . | 1 | . | 8 |
| *Phagnalon saxatile* (L.) Cass. | 1 | + | 1 | . | . | + | . | . | + | . | . | . | 1 | + | 1 | 8 |
| *Hypochaeris laevigata* (L.) Ces., Pass. et Gibelli | + | 1 | 1 | + | 1 | 1 | . | . | + | . | . | . | . | . | . | 7 |
| *Iberis semperflorens* L. | + | 1 | + | 1 | . | . | . | . | . | . | . | . | . | 1 | . | 5 |
| *Centaurea panormitana* Lojac. | 1 | . | + | + | 1 | . | . | . | . | . | . | . | . | . | . | 4 |
| *Matthiola incana* (L.) W.T.Aiton subsp. *rupestris* | . | + | + | . | . | + | + | . | . | . | . | . | . | . | . | 4 |
| *Silene fruticosa* L. | 1 | . | . | . | . | . | . | . | . | . | + | . | + | . | . | 3 |
| *Athamanta sicula* L. | . | + | . | 1 | . | . | . | . | . | . | . | . | . | . | . | 2 |
| *Ballota hispanica* (L.) Benth. | . | . | . | . | + | . | . | . | . | . | . | . | + | . | . | 2 |
| *Teucrium flavum* L. subsp. *flavum* | . | . | + | . | . | . | . | . | . | . | . | . | + | . | . | 2 |
| *Brassica rupestris* Raf. | . | . | . | . | . | . | . | + | . | . | . | . | . | . | + | 2 |
| *Sedum dasyphyllum* L. subsp. *dasyphyllum* | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | 2 |
| *Coronilla valentina* L. | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | 1 |
| *Convolvulus cneorum* L. | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | 1 |
| **Char. of the class *Parietarietea judaicae*** | | | | | | | | | | | | | | | | |
| *Capparis spinosa* L. | . | . | . | . | . | . | 1 | + | 1 | 1 | . | . | 1 | 1 | + | 7 |
| *Pennisetum setaceum* (Forssk.) Chiov. | . | . | . | . | . | . | 1 | 1 | 1 | 1 | . | 1 | 1 | 1 | . | 7 |
| *Parietaria judaica* L. | . | . | . | . | 1 | 1 | + | + | . | . | 1 | + | . | . | . | 6 |
| *Sedum sediforme* (Jacq.) Pau | . | . | . | . | . | . | . | + | . | + | . | + | + | 1 | + | 6 |
| *Hyoseris radiata* L. | + | . | . | . | + | . | + | . | . | . | + | . | . | . | . | 4 |
| *Ceterach officinarum* Willd. | | 1 | . | . | . | . | . | . | . | . | + | 1 | + | . | . | 4 |
| *Sonchus tenerrimus* L. | . | . | + | . | . | + | . | + | . | + | . | . | . | . | . | 4 |
| *Centranthus ruber* (L.) DC. | . | + | + | . | . | . | . | . | . | . | . | . | . | . | + | 3 |
| *Umbilicus horizontalis* (Guss.) DC. | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | 1 |
| **Transgr. of the class *Quercetea ilicis*** | | | | | | | | | | | | | | | | |
| *Ampelodesmos mauritanicus* (Poir.) T.Durand et Schinz | + | . | 1 | + | . | 1 | . | . | . | . | . | . | + | . | + | 6 |
| *Euphorbia dendroides* L. | + | . | . | . | . | . | . | . | 1 | + | . | . | + | 1 | + | 6 |
| *Prasium majus* L. | . | . | . | + | + | + | 1 | . | + | + | . | . | . | . | . | 6 |
| *Rhamnus alaternus* L. subsp. *alaternus* | . | . | . | + | . | 1 | 1 | . | . | . | + | . | . | . | . | 4 |
| *Artemisia arborescens* L. | . | . | . | . | . | . | + | + | . | . | . | . | . | + | . | 3 |
| *Pinus halepensis* Mill. | . | . | . | 1 | . | . | . | . | + | . | . | . | . | . | . | 2 |
| *Emerus major* Mill. | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Cytisus infestus* (C.Presl) Guss. | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Asparagus acutifolius* L. | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | 1 |
| *Pistacia terebinthus* L. | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | 1 |
| *Euphorbia bivonae* Steud. subsp. *bivonae* | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | 1 |
| *Asparagus albus* L. | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | 1 |
| **Other species** | | | | | | | | | | | | | | | | |
| *Campanula erinus* L. | . | + | . | . | + | + | + | . | + | . | + | + | . | . | . | 7 |
| *Bituminaria bituminosa* (L.) C.H.Stirt. | . | . | 1 | . | . | 1 | + | . | . | . | . | . | + | 1 | 1 | 6 |
| *Prospero autumnale* (L.) Speta | + | + | . | . | . | . | . | . | . | . | . | . | . | + | + | 4 |
| *Valantia muralis* L. | + | . | . | . | . | . | . | . | + | . | . | + | . | . | . | 3 |
| *Reseda alba* L. | . | + | . | + | + | . | . | . | . | . | . | . | . | . | . | 3 |
| *Reichardia picroides* (L.) Roth | . | . | . | . | . | + | + | + | . | . | . | . | . | . | . | 3 |
| *Mercurialis annua* L. | . | + | . | . | + | . | . | . | . | . | . | . | . | . | . | 2 |
| *Allium subhirsutum* L. | . | . | + | . | + | . | . | . | . | . | . | . | . | . | . | 2 |
| *Avena barbata* Pott ex Link | . | + | . | . | . | . | . | . | . | . | + | . | . | . | . | 2 |
| *Anthyllis maura* Beck | . | . | + | . | . | . | . | . | + | . | . | . | . | . | . | 2 |

**Table 7.** Continuation.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5* | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 150 | 110 | 150 | 160 | 186 | 190 | 160 | 170 | 150 | 180 | 330 | 330 | 300 | 300 | 270 | |
| Slope (°) | 90 | 90 | 90 | 85 | 85 | 85 | 90 | 90 | 90 | 90 | 85 | 90 | 85 | 85 | 85 | |
| Aspect | N | N | N | N | NW | NW | E | E | E | E | W | W | SW | SW | W | |
| Area ($m^2$) | 20 | 20 | 20 | 15 | 20 | 15 | 15 | 15 | 15 | 15 | 20 | 12 | 20 | 30 | 20 | |
| Total cover (%) | 55 | 55 | 50 | 55 | 60 | 60 | 50 | 50 | 55 | 60 | 65 | 60 | 60 | 60 | 50 | |
| Average height (cm) | 50 | 50 | 35 | 40 | 40 | 45 | 45 | 40 | 55 | 60 | 50 | 40 | 40 | 40 | 50 | |
| Species per relevé | 20 | 17 | 15 | 15 | 17 | 17 | 19 | 14 | 17 | 14 | 12 | 12 | 16 | 19 | 17 | Presence |
| *Dittrichia viscosa* (L.) Greuter subsp. *viscosa* | . | . | . | . | . | + | + | . | . | . | . | . | . | . | . | 2 |
| *Asphodelus ramosus* L. subsp. *ramosus* | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | 2 |
| *Theligonum cynocrambe* L. | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Lobularia maritima* (L.) Desv. | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | 1 |
| *Echium plantagineum* L. | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | 1 |
| *Charybdis maritima* (L.) Speta | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | 1 |
| *Trachynia distachya* (L.) Link. | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | 1 |

cliffs and rocky cut slopes, more or less shaded, dominated by *Lomelosia cretica*.

***Syndynamism:*** Pioneer vegetation that plays an edaphoclimatic role in the colonization processes of fresh and humid artificial rocky cut slopes and natural cliffs. In fact, on slopes shaped by the excavation of limestone that have been left undisturbed, the chasmophytic association appears naturally restored. It is in catenal contact with the following associations: a) *Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov. (at the base of shady and nitrified walls); b) *Olopto miliacei-Pennisetetum setacei* ass. nov. (at the base of sunny and xeric walls); grasslands associated with *Penniseteto setacei-Hyparrhenietum hirtae* and aspects of the *Ruto-Oleo sylvestris* sigmetum located on the slopes above the road system (Fig. 4D).

***Synchorology:*** This phytocoenosis is frequent on the cliffs and cut slopes of Monte Pellegrino. It is also widespread in the mountains of Palermo and Trapani areas (up to 900 m a.s.l.) and has been reported for small and isolated locations in the Nebrodi Mountains at Rocche del Crasto (Brullo and Marcenò 1979).

## Communities of masonry guardwalls

**Cl.**: *STIPO-TRACHYNIETEA DISTACHYAE* S. Brullo in S. Brullo et al. 2001
Mediterranean calciphilous annual and ephemeroid swards and grasslands

**Ord.**: *BRACHYPODIETALIA DISTACHYI* Rivas-Mart. 1978
Western Mediterranean ephemeral winter pastures on shallow sandy and loamy soils over limestone, dolomite, and gypsum.

**All.**: *HYPOCHOERIDION ACHYROPHORI* Biondi & Guerra 2008
Annual community, xerophytic, pioneer, basiphilous, of the European Central Mediterranean area in the thermomediterranean and mesotemperate bioclimatic belts. It is part of the *Trachynion distachyae* alliance of the western Mediterranean, and reaches its western distribution limit in the Mediterranean area around Provence.

9) Groupment with *STIPELLULA CAPENSIS*

***Phytosociological data:*** Table 9.

***Diagnostic species:*** *Stipellula capensis* (dom.).

***Description:*** Therophytic heliophilous and xerophilous formation, with spring phenology, growing in the soil accumulated on the tops of old guardwalls on the road margin (parapets) due to deterioration caused by weathering events. The phytocoenosis is physiognomically dominated by *Stipellula capensis*, which is associated with other ephemeral species.

***Syndynamism:*** Pioneer vegetation mainly related to the more xeric geosigmetum of the road system. It is in catenal contact with ruderal and wall formations, such as the *Olopto miliacei-Pennisetetum setacei* ass. nov.

***Synchorology:*** *Stipellula capensis* vegetation is quite widespread in Sicily (Brullo et al. 2000; Gianguzzi and La Mantia 2008), although it has been little investigated from a phytosociological point of view.

## Communities of road margins

**Cl.:** *ARTEMISIETEA VULGARIS* Lohmeyer et al. in Tx. Ex von Rochow1951
Perennial (sub)xerophilous ruderal vegetation of the temperate and submediterranean regions of Europe.

**Ord.**: *ELYTRIGIO REPENTIS-DITTRICHIETALIA VISCOSAE* Mucina in Mucina et al. 2016
Anthropogenic sub-ruderal and ruderal grasslands and herblands of submediterranean and Mediterranean Southern Europe.

**All.:** *BROMO-ORYZOPSION MILIACEAE* O. Bolòs 1970
Thermomediterranean sub-ruderal perennial grasslands on disturbed road margins of the Mediterranean.

10) *OLOPTO MILIACEI-PENNISETETUM SETACEI* Gianguzzi ass. nov.

***Phytosociological data:*** Table 21 in Gianguzzi et al. 1996.

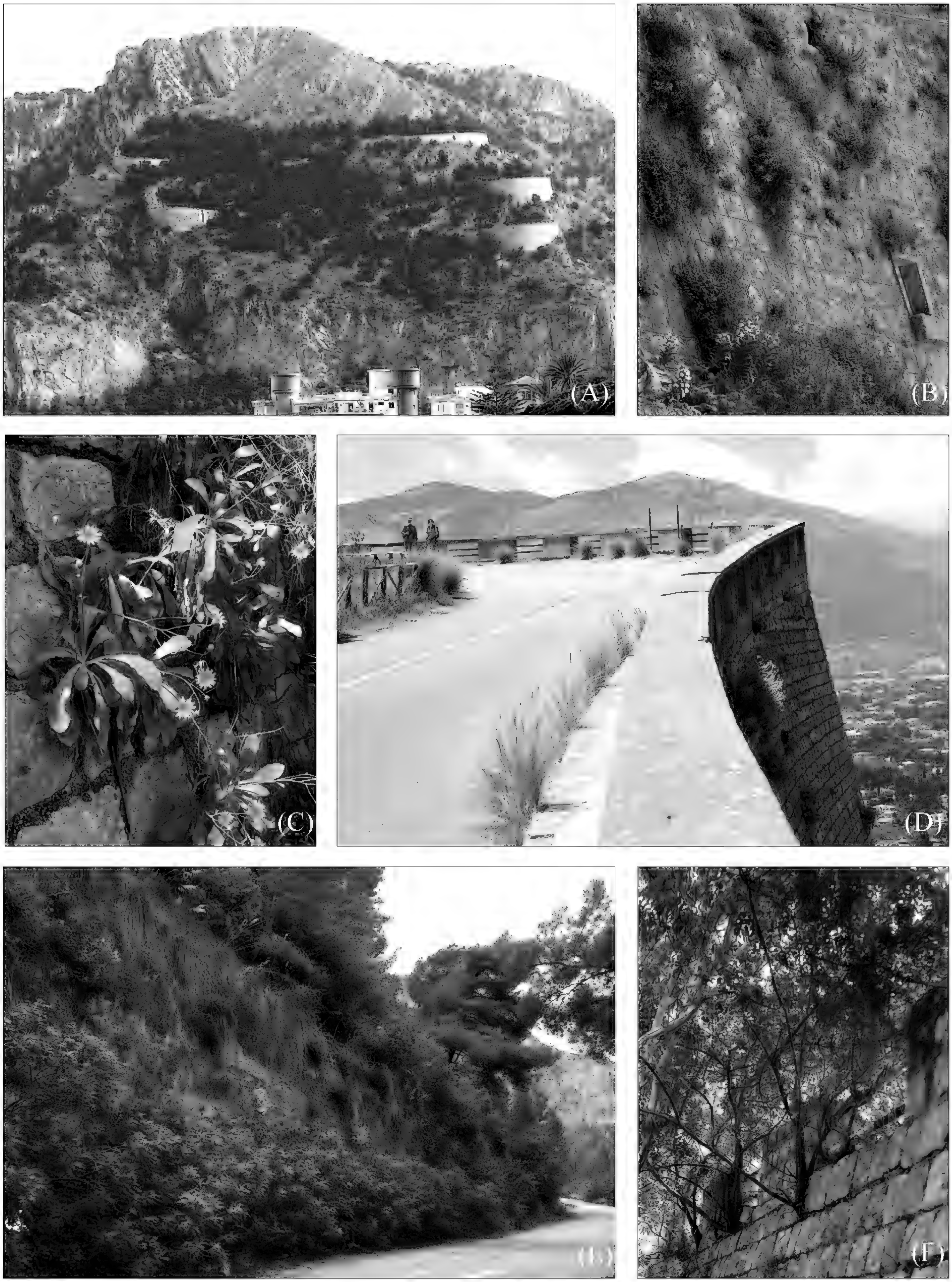


**Figure 3.** Shady-mesic slopes of the road system: **A** view of via Monte Ercta; **B** *Athamanto-Parietarietum judaicae*; **C** *Helichryso-Hypochaeridetum laevigatae*; **D** vegetation of the *Olopto-Pennisetetum setacei* (road margins) and *Diantho-Helichrysetum panormitanae* (walls); **E** vegetation of the *Teucrio flavi-Rhoetum coriariae*; **F** woody plants at the base of masonry guardwalls.


**Figure 4.** Xerophilous slopes of the road system: **A** view of via Bonanno; **B** *Antirrhinetum siculi*; **C** *Capparidetum rupestris*; **D** aspects of the series *Ruto-Oleo sylvestris* sigmetum; **E** *Olopto-Pennisetetum setacei* (road margins) and *Penniseto setacei-Hyparrhenietum* (slope); **F** vegetation of the *Rhamno-Euphorbietum dendroidis* subass. *artemisietosum arborescentis*.

**Table 8.** *Scabioso creticae-Centauretum ucriae* Brullo et Marcenò 1979 subass. *typicum*.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 47 | 165 | 170 | 180 | 250 | 330 | 330 | |
| Slope (°) | 88 | 85 | 90 | 90 | 90 | 85 | 90 | |
| Aspect | NW | N | NW | NW | NW | W | W | |
| Area (m²) | 20 | 40 | 30 | 40 | 20 | 30 | 20 | |
| Total cover (%) | 60 | 60 | 50 | 55 | 55 | 65 | 60 | |
| Herbaceous cover (%) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | |
| Average height (cm) | 24 | 21 | 20 | 20 | 29 | 28 | 23 | Presence |
| **Characteristic and differential species of association** | | | | | | | | |
| *Lomelosia cretica* (L.) Greuter et Burdet | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 7 |
| *Helichrysum panormitanum* Guss. | 2 | 2 | 2 | 1 | 2 | + | + | 7 |
| *Euphorbia bivonae* Steud. subsp. *bivonae* | 1 | + | . | . | 1 | . | . | 3 |
| *Centaurea panormitana* Lojac. | 1 | . | . | 1 | . | . | . | 2 |
| *Convolvulus cneorum* L. | . | . | . | . | . | + | . | 1 |
| **Char. of the alliance *Dianthion rupicolae* and class *Asplenietea trichomanis*** | | | | | | | | |
| *Dianthus rupicola* Biv. | 1 | 1 | 1 | + | 2 | 1 | 1 | 7 |
| *Seseli bocconei* Guss. | 1 | + | . | . | + | + | . | 4 |
| *Phagnalon saxatile* (L.) Cass. | + | . | 1 | 1 | 1 | 1 | 1 | 6 |
| *Iberis semperflorens* L. | + | + | 1 | + | 1 | . | . | 5 |
| *Matthiola incana* (L.) W.T.Aiton subsp. *rupestris* | 1 | + | 1 | + | 1 | . | . | 5 |
| *Coronilla valentina* L. | 1 | 1 | 1 | 1 | . | . | . | 4 |
| *Brassica rupestris* Raf. | 1 | 1 | . | 1 | 1 | . | . | 4 |
| *Ballota hispanica* (L.) Benth | + | . | . | . | 1 | 1 | + | 4 |
| *Hypochaeris laevigata* (L.) Ces., Pass. et Gibelli | . | 1 | 1 | 1 | . | . | + | 4 |
| *Sedum dasyphyllum* L. subsp. *dasyphyllum* | + | . | . | . | . | 1 | + | 3 |
| *Silene fruticosa* L. | . | . | . | . | 1 | 1 | 1 | 3 |
| *Glandora rosmarinifolia* (Ten.) D.C.Thomas | . | . | . | + | . | . | . | 1 |
| *Teucrium flavum* L. subsp. *flavum* | . | . | . | . | 1 | . | . | 1 |
| **Transgr. of the class *Parietarietea*** | | | | | | | | |
| *Ceterach officinarum* Willd. | . | . | 1 | + | 1 | 1 | 1 | 5 |
| *Antirrhinum siculum* Mill. | . | + | 1 | + | + | . | . | 4 |
| *Hyoseris radiata* L. | + | . | . | . | . | 1 | + | 3 |
| *Sedum sediforme* (Jacq.) Pau | . | 1 | 1 | . | 1 | . | . | 3 |
| *Umbilicus horizontalis* (Guss.) DC. | . | + | . | . | 1 | . | 1 | 3 |
| *Parietaria judaica* L. | + | . | . | . | 1 | . | . | 2 |
| *Capparis spinosa* L. | 1 | . | . | . | . | . | . | 1 |
| *Reichardia picroides* (L.) Roth | . | . | . | . | + | . | . | 1 |
| **Transgr. of the class *Quercetea ilicis*** | | | | | | | | |
| *Euphorbia dendroides* L. | 1 | 1 | 1 | . | . | 1 | + | 5 |
| *Prasium majus* L. | . | + | . | . | 1 | 2 | 2 | 4 |
| *Asparagus acutifolius* L. | + | . | . | . | . | + | 1 | 3 |
| *Ampelodesmos mauritanicus* (Poir.) T.Durand et Schinz | . | 1 | 1 | 1 | . | . | . | 3 |
| *Allium subhirsutum* L. | + | + | . | . | . | . | . | 2 |
| *Rhamnus alaternus* L. subsp. *alaternus* | . | . | . | . | . | 1 | 1 | 2 |
| *Asparagus albus* L. | . | . | . | . | . | + | + | 2 |
| *Melica minuta* L. | + | . | . | . | . | . | . | 1 |
| *Cytisus infestus* (C.Presl) Guss. | . | . | + | . | . | . | . | 1 |
| *Artemisia arborescens* L. | . | . | . | . | + | . | . | 1 |
| **Other species** | | | | | | | | |
| *Galium cinereum* All. | 1 | 1 | + | + | 1 | . | . | 5 |
| *Micromeria fruticulosa* (Bertol.) Šilić | 2 | 1 | 1 | 1 | . | . | 1 | 5 |
| *Bituminaria bituminosa* (L.) C.H.Stirt. | 1 | . | . | + | . | 1 | 1 | 4 |
| *Allium polyanthum* Schult. et Schult.f. | . | 1 | 1 | + | + | . | . | 4 |
| *Campanula erinus* L. | . | . | . | . | + | + | 1 | 3 |
| *Asphodelus ramosus* L. subsp. *ramosus* | + | . | . | . | 1 | . | . | 2 |
| *Prospero autumnale* (L.) Speta | . | + | . | . | + | . | . | 2 |
| *Elaeoselinum asclepium* (L.) Bertol. | . | . | 1 | + | . | . | . | 2 |
| *Calendula suffruticosa* Vahl subsp. *fulgida* (Raf.) Guadagno | . | . | . | . | . | 1 | 1 | 2 |
| *Echium parviflorum* Moench | . | . | . | . | . | 1 | + | 2 |
| *Hirschfeldia incana* (L.) Lagr.-Foss. subsp. *incana* | . | . | . | . | . | + | + | 2 |
| *Dactylis glomerata* L. | . | . | . | . | . | + | + | 2 |
| *Narcissus tazetta* L. | . | . | + | . | . | . | . | 1 |
| *Charybdis maritima* (L.) Speta | . | . | + | . | . | . | . | 1 |

**Table 8.** Continuation.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Presence |
|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 47 | 165 | 170 | 180 | 250 | 330 | 330 | |
| Slope (°) | 88 | 85 | 90 | 90 | 90 | 85 | 90 | |
| Aspect | NW | N | NW | NW | NW | W | W | |
| Area ($m^2$) | 20 | 40 | 30 | 40 | 20 | 30 | 20 | |
| Total cover (%) | 60 | 60 | 50 | 55 | 55 | 65 | 60 | |
| Herbaceous cover (%) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | |
| Average height (cm) | 24 | 21 | 20 | 20 | 29 | 28 | 23 | |
| *Jacobaea delphiniifolia* (Vahl) Pelser et Veldkamp | . | . | . | + | . | . | . | 1 |
| *Theligonum cynocrambe* L. | . | . | . | . | + | . | . | 1 |
| *Veronica persica* Poir. | . | . | . | . | + | . | . | 1 |
| *Valantia muralis* L. | . | . | . | . | + | . | . | 1 |
| *Smyrnium olusatrum* L. | . | . | . | . | + | . | . | 1 |
| *Lathyrus clymenum* L. | . | . | . | . | . | 1 | . | 1 |
| *Avena barbata* Pott ex Link | . | . | . | . | . | 1 | . | 1 |
| *Convolvulus elegantissimus* Mill. | . | . | . | . | . | 1 | . | 1 |
| *Reseda alba* L. | . | . | . | . | . | + | . | 1 |
| *Ferula communis* L. | . | . | . | . | . | + | . | 1 |
| *Carlina sicula* Ten. | . | . | . | . | . | + | . | 1 |

**Table 9.** Groupment with *Stipellula capensis*.

| Relevé (n°) | 1 | 2 | 3 | 4 | Presence |
|---|---|---|---|---|---|
| Altitude (m) | 150 | 180 | 300 | 350 | |
| Slope (°) | 1 | 5 | 8 | 10 | |
| Aspect | S | S | SE | SE | |
| Area ($m^2$) | 1 | 1 | 1 | 1 | |
| Total cover (%) | 75 | 85 | 85 | 90 | |
| Average height (cm) | 8 | 8 | 8 | 10 | |
| Species per relevé | 21 | 20 | 18 | 23 | |
| **Dominant species** | | | | | |
| *Stipellula capensis* (Thunb.) Röser et H.R.Hamasha | 4 | 4 | 3 | 5 | 4 |
| **Char. of the alliance** | | | | | |
| *Trachynia distachya* (L.) Link | 2 | 2 | 2 | 1 | 4 |
| *Euphorbia exigua* L. | + | + | 1 | + | 4 |
| *Trisetaria aurea* (Ten.) Pignatti | + | 2 | . | + | 3 |
| *Sagina apetala* Ard. | . | . | + | 1 | 2 |
| **Char. of the order and class** | | | | | |
| *Anisantha fasciculata* (C.Presl) Nevski | 2 | 1 | 2 | 2 | 4 |
| *Silene colorata* Poir. | 2 | + | 1 | 1 | 4 |
| *Trifolium campestre* Schreb. | 1 | 1 | + | 1 | 4 |
| *Trifolium scabrum* L. | 1 | + | 2 | 2 | 4 |
| *Catapodium hemipoa* (Delile ex Spreng.) M.Laínz | 2 | 1 | + | 1 | 4 |
| *Plantago afra* L. | + | + | + | + | 4 |
| *Hypochaeris achyrophorus* L. | + | + | 2 | + | 4 |
| *Arenaria leptoclados* (Rchb.) Guss. | + | + | . | 1 | 3 |
| *Bellis annua* L. | + | . | + | + | 3 |
| *Crupina crupinastrum* (Moris) Vis. | . | . | + | + | 2 |
| **Other species** | | | | | |
| *Lotus ornithopodioides* L. | 1 | + | 1 | 2 | 4 |
| *Geranium molle* L. | 1 | + | 1 | + | 4 |
| *Lagurus ovatus* L. subsp. *ovatus* | + | 1 | . | 1 | 3 |
| *Hyoseris radiata* L. | + | . | 1 | 1 | 3 |
| *Misopates orontium* (L.) Raf. | . | + | 1 | 1 | 3 |
| *Polypodium cambricum* L. | 1 | + | . | . | 2 |
| *Pennisetum setaceum* (Forssk.) Chiov. | + | 1 | . | . | 2 |
| *Lotus edulis* L. | + | + | . | . | 2 |
| *Trifolium suffocatum* L. | + | . | + | + | 2 |
| *Asphodelus ramosus* L. subsp. *ramosus* | . | 1 | . | . | 1 |
| *Carduus pycnocephalus* L. | . | . | . | + | 1 |
| *Umbilicus horizontalis* (Guss.) DC. | . | . | . | + | 1 |

***Synonym:*** *Penniseto setacei-Hyparrhenietum hirtae* var. with *Oryzopsis miliacea* (L.) Asch. & Schweinf (in Gianguzzi et al. 1996).

***Holotypus***: Rel. 1, Table 21, in Gianguzzi et al. (1996, p. 104).

***Diagnostic species:*** *Pennisetum setaceum* (dom.), *Oloptum miliaceum* (= *Oryzopsis miliacea*), *Lobularia maritima*, *Foeniculum vulgare* subsp. *piperitum*, *Sixalis atropurpurea* subsp. *maritima*.

***Floristic-syntaxonomical notes:*** *Pennisetum setaceum*, native of the Middle East and the Arabian Peninsula, has now become thermo-cosmopolite (EPPO 2020) and an invasive alien species that is widespread in the Mediterranean area (D'Amico and Gianguzzi 2006; Pasta et al. 2010). In Sicily, the first record of *Pennisetum setaceum* referred precisely to Monte Pellegrino (Pignatti-Wikus 1963), followed by numerous others that highlighted a constant increase in its distribution across the region (Gianguzzi et al. 1996; D'Amico and Gianguzzi 2006). On the carbonate outcrops of the study area, nowadays it forms large and stabilized grasslands (Fig. 4E) related to the *Penniseto setacei-Hyparrhenietum hirtae* association (Gianguzzi et al. 1996) – of the *Hyparrhenion hirtae* alliance, order *Cymbopogono-Brachypodietalia ramosi*, class *Lygeo-Stipetea* that belongs to the oleaster series (Gianguzzi and Bazan 2019, 2020; Gianguzzi et al. 2020). Over time, it has replaced the vegetation with *Hyparrhenia hirta*, mostly in the thermomediterranean bioclimatic belt (Gianguzzi et al. 1996). In fact, *Pennisetum setaceum* is a strongly competitive species and creates a linear aspect of vegetation along the road margins, previously ascribed to a variant with *Oloptum miliaceum* (sub *Oryzopsis miliacea*; Gianguzzi et al. 1996) of the above-mentioned association. However, this second case consists of a nitrophilous-ruderal coenosis ascribable to the *Bromo-Oryzopsion miliaceae* alliance. As highlighted by Mucina et al. (2016), "... the position of this alliance is contentious. Rivas-Martínez et al. (1999) placed this alliance in the *Agropyretalia repentis* and only three years later Rivas-Martínez (2002) re-classified this unit within the *Carthametalia lanati*. Biondi et al. (2001) gave preference to the *Brachypodio ramosi-Dactylidetalia*. In any case, these conflicting opinions have been obviously motivated by the transitional character of the unit that straddles the border between pseudosteppes and ruderal grass-rich vegetation". On this basis, the description of the new syntaxon in question is deemed appropriate (art. 24b, code of phytosociological nomenclature).

***Description:*** It is a hemicryptophytic, thermo-xerophilous and paucispecific formation, whose physiognomy is dominated by *Pennisetum setaceum* which forms a continuous vegetation belt located along the road margins in the more xeric and sunny parts (Figs 3D, 4E). Compared to *Penniseto setacei-Hyparrhenietum hirtae* – related to rocky limestone slopes – the phytocoenosis in question is different in its poorer floristic composition and the frequency of the above-mentioned ruderal species that are indicated among the typical characteristics (Gianguzzi et al. 1996).

***Syndynamism:*** The association belongs to the more xeric geosigmetum of the road system. In the absence of maintenance works, it tends to colonize the edges of walls that act as parapets, where it is located both inside and outside the road surface, and sometimes also on top. The association is in catenal contact with the following coenoses: a) *Trachynia distachya* groupment (therophytic grassland located in the soil accumulations among the clumps); b) *Capparidetum rupestris* (chasmo-nitrophilous vegetation of the upper parts of sunny and sheltered walls); c) *Rhamno alaterni-Euphorbietum dendroidis* Géhu & Biondi 1997 *artemisietosum arborescentis* subass. nov. (guardwalls of sunny and sheltered parts of the road system).

***Synchorology:*** The phytocoenosis is widespread in the study area, especially along the most xeric parts of the southern and western slopes of the promontory. It is booming in Sicily, mostly along the roads and railways of the coastal belt and, in some cases, in the interior (Gianguzzi et al. 1996, D'Amico and Gianguzzi 2006). This is due to the peculiarity of the seeds (high quantity and high germinability), the anemophilous dissemination (spread over long distances), the biological characteristics of the plant (thick clumps resistant to fires that take space and light from other herbaceous plants) and, in addition – probably – climatic changes.

**Cl.**: *QUERCETEA ILICIS* Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
Thermo-mesomediterranean pine and oak forests and associated Mediterranean maquis.

**Ord.**: *PISTACIO LENTISCI-RHAMNETALIA ALATERNI* Rivas-Martínez 1975
Thermo-mesomediterranean low-growth matorral, maquis, and garrigue of the Mediterranean Basin.

**All.**: *OLEO SYLVESTRIS-CERATONION SILIQUAE* Br.-Bl. ex Guinochet et Drouineau 1944
Thermomediterranean calcicolous maquis of the Liguro-Tyrrhenian seaboards.

11) *RHAMNO ALATERNI-EUPHORBIETUM DENDROIDIS* Géhu & Biondi 1997 *ARTEMISIETOSUM ARBORESCENTIS* subass. nov.

***Phytosociological data:*** Table 10.

***Holotypus:*** Rel. 5, Table 10.

***Diagnostic species:*** *Euphorbia dendroides* (dom.), *Artemisia arborescens*, *Pennisetum setaceum*.

***Syntaxonomic notes:*** The scrub vegetation with Euphorbia dendroides of Sicily is referred to the association *Rhamno alaterni-Euphorbietum dendroidis* Géhu & Biondi 1997 (= *Oleo-Lentiscetum euphorbietosum Molinier* 1954; *Oleo-Euphorbietum dendroidis* Trinajstic 1974; *Oleo-Euphorbietum dendroidis* Trinajstic 1975), divided into the following subassociations, to be considered as geographic vicariants: a) subass. *typicum*; b) subass. *phlomidetosum fruticosae* (Brullo & Marcenò 1985) Gianguzzi et al. 2016 (with *Phlomis fruticosa* L.), on gypsic substrates of the hinterland of Sicily; c) *euphorbietosum bivonae* (Gianguzzi, Ilardi & Raimondo 1996) Gianguzzi et al. 2016 (with *Euphorbia bivonae*), on limestone-dolomitic rocks of Palermo area, Trapani area and near Sciacca; d) *rhamnetosum*

**Table 10.** *Rhamno alaterni-Euphorbietum dendroidis* Géhu & Biondi 1997 subass. *artemisietosum arborescentis* subass. nov.

| Relevé (n°) | 1 | 2 | 3 | 4 | 5* | 6 | Presence |
|---|---|---|---|---|---|---|---|
| Altitude (m) | 300 | 310 | 320 | 350 | 350 | 380 | |
| Slope (°) | 5 | 5 | 5 | 5 | 5 | 5 | |
| Aspect | SW | W | W | SW | SW | SW | |
| Area ($m^2$) | 40 | 60 | 60 | 50 | 50 | 50 | |
| Total cover (%) | 100 | 100 | 100 | 90 | 80 | 90 | |
| Average height (cm) | 40 | 40 | 50 | 50 | 50 | 50 | |
| Species per relevé | 9 | 11 | 10 | 12 | 9 | 11 | |
| **Characteristic and differential species of the association and subass.** | | | | | | | |
| *Euphorbia dendroides* L. | 3 | 3 | 3 | 2 | 3 | 2 | 6 |
| *Artemisia arborescens* L. | 3 | 3 | 3 | 4 | 3 | 3 | 6 |
| *Pennisetum setaceum* (Forssk.) Chiov. | 3 | 3 | 3 | 3 | 2 | 3 | 6 |
| **Char. of the alliance, order and class** | | | | | | | |
| *Rhamnus alaternus* L. subsp. *alaternus* | 1 | 2 | 2 | + | 2 | 1 | 6 |
| *Pistacia terebinthus* L. | 1 | 2 | 1 | + | . | 1 | 5 |
| *Asparagus albus* L. | 2 | 1 | 1 | . | 1 | . | 4 |
| *Euphorbia bivonae* Steud. subsp. bivonae | 1 | . | . | + | . | . | 2 |
| *Olea europaea* L. var. *sylvestris* (Mill.) Lehr. | . | 1 | . | + | . | + | 3 |
| *Asparagus acutifolius* L. | . | . | . | . | + | + | 2 |
| **Other species** | | | | | | | |
| *Bituminaria bituminosa* (L.) C.H.Stirt. | 3 | 2 | 2 | + | . | . | 4 |
| *Phagnalon saxatile* (L.) Cass. | . | . | 1 | 1 | 1 | 1 | 4 |
| *Carlina sicula* Ten. | . | 1 | . | 1 | + | . | 3 |
| *Clinopodium nepeta* (L.) Kuntze | + | . | . | 1 | 1 | 1 | 4 |
| *Lomelosia cretica* (L.) Greuter et Burdet | . | . | + | . | . | + | 2 |
| *Reseda alba* L. | . | . | . | 1 | . | 1 | 2 |
| *Spartium junceum* L. | . | 1 | . | . | . | . | 1 |
| *Ailanthus altissima* (Mill.) Swingle | . | 1 | . | . | . | . | 1 |
| *Silene fruticosa* L. | . | . | 2 | . | . | . | 1 |

*oleoidis* (Brullo & Marcenò 1985) Gianguzzi et al. 2016 [with *Rhamnus lycioides* L. subsp. *oleoides* (L.) Jahand and Maire], on calcareous, marly and calcarenitic substrates of Trapani and Agrigento are and Egadi Islands (Gianguzzi et al. 2006); e) *celtidetosum aetnensis* (Brullo & Marcenò 1985) Gianguzzi et al. 2016 [*Celtis tournefortii* Lam. subsp. *aetnensis* (Tornab.) Raimondo & Schicchi], on calcareous debris cones of the Sicani Mountains (Gianguzzi et al. 2014a, 2014b). A further xero-nitrophilic vicariant was detected in the study area and diversified by the frequency of *Artemisia arborescens*, proposed as a new subassociation.

***Description:*** Thermo-xerophilous, heliophilous, and nitrophilous, paucispecific maquis formations, clearly dominated by *Euphorbia dendroides*, associated with *Artemisia arborescens* and *Pennisetum setaceum*, with high cover values. The phytocoenosis is typical of warm, sunny, and xeric slopes on carbonate substrata and tends generally to colonize anthropogenic habitats. In particular, it is spread on old walls and ruins.

***Syndynamism:*** In the road system in question, the phytocoenosis takes part in the more xeric geosigmetum, related to the road margins of the southern and western slopes of the promontory (Fig. 4F). It forms nitrophilous-xerophilous maquis vegetation located on the upper parts of guardwalls, sometimes covering them. The association is catenal with the following: a) *Olopto miliacei-Pennisetetum setacei* ass. nov. (road margin vegetation of *Pennisetum setaceum*); b) *Antirrhinetum siculi* (on not very high walls); c) *Capparidetum rupestris* (upper parts of sunny and sheltered walls).

***Synchorology:*** The phytocoenosis was mainly detected along the more xeric parts of the road system on the southern and western sides of the promontory.

12) *TEUCRIO FLAVI-RHOETUM CORIARIAE* Gianguzzi ass. nov.

***Phytosociological data:*** Table 11.

***Synonym:*** Groupment with *Rhus coriaria* (in Gianguzzi et al. 1996); *Clematido cirrhosae-Rubetum ulmifolii* subass. *rhoetosum coriariae* Gianguzzi & La Mantia 2008 (in Gianguzzi and La Mantia 2008).

***Holotypus:*** Rel. 2, Table 11.

***Diagnostic species:*** *Rhus coriaria* (dom.), T*eucrium flavum* subsp. *flavum*, *Bituminaria bituminosa*.

***Floristic-syntaxonomical notes:*** *Rhus coriaria* is a species with a southern range (Pignatti 1982; Pignatti et al. 2017) that is widespread from the Canary Islands to the Middle East (Davis 1967; Tutin et al. 1968; Kurucu et al. 1993; Bloshenko and Letchamo 1995). It is quite common in Italy, as well as in Sicily, as a residue of ancient

**Table 11.** *Teucrio flavi-Rhoetum coriariae* Gianguzzi ass. nov.

| Relevé (n°) | 1 | 2* | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 145 | 140 | 150 | 120 | 180 | 100 | 8 | 8 | 150 | 90 | 95 | 90 | |
| Slope (°) | 5 | 5 | 25 | 30 | 25 | 35 | 30 | 30 | 15 | 20 | 25 | 30 | |
| Aspect | N | N | NE | NE | NE | N | N | N | N | N | N | N | |
| Area ($m^2$) | 100 | 100 | 50 | 100 | 50 | 100 | 80 | 80 | 100 | 80 | 80 | 50 | |
| Total cover (%) | 100 | 100 | 70 | 70 | 80 | 95 | 80 | 70 | 90 | 95 | 90 | 85 | |
| Shrubby cover (%) | 70 | 75 | 70 | 70 | 75 | 70 | 70 | 50 | 85 | 90 | 85 | 80 | |
| Herbaceous cover (%) | 35 | 30 | 30 | 25 | 30 | 35 | 50 | 60 | 70 | 65 | 70 | 50 | |
| Average height (cm) | 3 | 2.8 | 1.5 | 1.8 | 1.6 | 1.5 | 1.2 | 1.3 | 2.8 | 2.2 | 2.0 | 2.2 | |
| Species per relevé | 28 | 25 | 19 | 11 | 12 | 19 | 14 | 15 | 23 | 25 | 19 | 25 | Presence |
| **Characteristic and differential species of the association** | | | | | | | | | | | | | |
| *Rhus coriaria* L. | 5 | 5 | 2 | 4 | 3 | 2 | 2 | 2 | 4 | 3 | 4 | 3 | 12 |
| *Teucrium flavum* L. subsp. *flavum* | 2 | + | 3 | + | 1 | 2 | 1 | 1 | + | + | . | + | 11 |
| *Bituminaria bituminosa* (L.) C.H.Stirt. | 1 | + | 1 | + | . | 2 | . | + | + | + | + | + | 10 |
| **Char. of the alliance *Oleo-Ceratonion*** | | | | | | | | | | | | | |
| *Euphorbia dendroides* L. | + | 1 | . | + | + | . | 1 | + | . | . | . | 2 | 7 |
| *Olea europaea* L. var. *sylvestris* (Mill.) Lehr. | 1 | + | . | . | . | + | . | + | . | . | . | . | 4 |
| *Teucrium fruticans* L. | + | . | . | . | . | . | . | . | . | . | . | . | 1 |
| **Char. of the order *Pistacio lentisci-Rhamnetalia alaterni* and class *Quercetea ilicis*** | | | | | | | | | | | | | |
| *Rubia peregrina* L. | 3 | 2 | + | + | . | 1 | + | + | 1 | 1 | 1 | + | 11 |
| *Asparagus acutifolius* L. | 1 | 1 | + | . | . | . | + | . | 1 | 1 | 1 | + | 8 |
| *Rhamnus alaternus* L. subsp. *alaternus* | 1 | 1 | . | 1 | + | 1 | . | . | 1 | + | . | + | 8 |
| *Ampelodesmos mauritanicus* (Poir.) T.Durand et Schinz | 3 | 1 | + | . | 1 | 1 | . | . | 1 | . | . | 1 | 7 |
| *Clematis cirrhosa* L. | . | + | . | . | + | . | . | + | + | . | + | . | 5 |
| *Allium subhirsutum* L. | 2 | 1 | . | . | . | . | . | . | + | + | + | + | 6 |
| *Hedera helix* L. | + | . | + | . | . | + | . | 1 | 1 | . | + | . | 6 |
| *Arisarum vulgare* O.Targ.Tozz. | 1 | 1 | . | . | . | . | + | . | 1 | 1 | . | + | 6 |
| *Fraxinus ornus* L. | . | . | . | . | + | + | . | . | + | 1 | 1 | + | 6 |
| *Pistacia terebinthus* L. | 1 | + | . | . | . | . | . | . | + | 1 | . | + | 5 |
| *Smilax aspera* L. | 2 | 1 | + | . | . | + | . | . | . | . | . | + | 5 |
| *Ruta chalepensis* L. | + | . | + | . | . | . | . | . | + | + | . | . | 4 |
| *Euphorbia characias* L. | . | 1 | . | . | . | . | + | 1 | . | + | . | . | 4 |
| *Rosa sempervirens* L. | . | . | . | . | . | . | + | 1 | . | . | 1 | 2 | 4 |
| *Prasium majus* L. | + | . | . | . | . | + | . | + | . | . | . | . | 3 |
| *Phillyrea latifolia* L. | 1 | . | . | + | . | + | . | . | . | . | . | . | 3 |
| *Quercus ilex* L. | . | . | . | + | 1 | 1 | . | . | . | . | . | . | 3 |
| *Ruscus aculeatus* L. | . | + | + | . | . | . | . | . | . | . | . | . | 2 |
| *Lonicera implexa* Aiton | . | . | . | . | . | . | 1 | 1 | . | . | . | . | 2 |
| *Pistacia lentiscus* L. | 2 | + | + | . | . | . | . | . | . | . | . | . | 3 |
| *Anagyris foetida* L. | 1 | . | . | . | . | 1 | . | . | . | . | . | . | 2 |
| *Osyris alba* L. | . | + | + | . | . | . | . | . | . | . | . | . | 2 |
| *Emerus major* Mill. | . | 1 | . | . | . | . | . | . | . | . | . | . | 1 |
| **Transgr. of the class *Crataego-Prunetea*** | | | | | | | | | | | | | |
| *Rubus ulmifolius* Schott | 2 | 1 | 1 | + | 1 | 1 | 2 | 2 | 1 | 1 | 1 | + | 12 |
| *Crataegus monogyna* Jacq. | . | . | . | . | . | . | 1 | . | 1 | 2 | 1 | 2 | 5 |
| *Rosa canina* L. | . | . | 1 | . | . | 2 | . | . | . | . | . | . | 2 |
| *Prunus spinosa* L. | . | . | + | . | . | . | . | . | . | . | . | . | 1 |
| **Other species** | | | | | | | | | | | | | |
| *Vicia villosa subsp. varia* (Host) Corb. | 2 | 1 | . | . | + | . | + | + | 1 | 1 | 1 | + | 9 |
| *Oxalis pes caprae* L. | 1 | 1 | . | . | . | . | 2 | 2 | 2 | 3 | 2 | 1 | 8 |
| *Acanthus mollis* L. subsp. *mollis* | 2 | 2 | + | + | . | 1 | . | . | . | . | . | + | 6 |
| *Brachypodium retusum* (Pers.) P.Beauv. | 1 | . | . | . | . | . | . | . | 1 | 1 | 1 | + | 5 |
| *Clinopodium nepeta* (L.) Kuntze | + | . | . | . | . | + | . | . | . | + | 1 | 1 | 5 |
| *Ferula communis* L. | . | . | + | + | . | . | . | . | + | + | + | . | 5 |
| *Carlina sicula* Ten. | . | . | . | . | . | . | . | . | + | + | + | + | 4 |
| *Scrophularia canina* L. | . | + | + | . | + | . | . | . | . | . | . | . | 3 |
| *Galium cinereum* All. | . | 1 | . | . | . | . | 1 | . | . | . | + | . | 3 |

**Table 11.** Continuation.

| Relevé (n°) | 1 | 2* | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 145 | 140 | 150 | 120 | 180 | 100 | 8 | 8 | 150 | 90 | 95 | 90 | |
| Slope (°) | 5 | 5 | 25 | 30 | 25 | 35 | 30 | 30 | 15 | 20 | 25 | 30 | |
| Aspect | N | N | NE | NE | NE | N | N | N | N | N | N | N | |
| Area (m²) | 100 | 100 | 50 | 100 | 50 | 100 | 80 | 80 | 100 | 80 | 80 | 50 | |
| Total cover (%) | 100 | 100 | 70 | 70 | 80 | 95 | 80 | 70 | 90 | 95 | 90 | 85 | |
| Shrubby cover (%) | 70 | 75 | 70 | 70 | 75 | 70 | 70 | 50 | 85 | 90 | 85 | 80 | |
| Herbaceous cover (%) | 35 | 30 | 30 | 25 | 30 | 35 | 50 | 60 | 70 | 65 | 70 | 50 | |
| Average height (cm) | 3 | 2.8 | 1.5 | 1.8 | 1.6 | 1.5 | 1.2 | 1.3 | 2.8 | 2.2 | 2.0 | 2.2 | |
| Species per relevé | 28 | 25 | 19 | 11 | 12 | 19 | 14 | 15 | 23 | 25 | 19 | 25 | Presence |
| *Seseli bocconei* Guss. | . | . | + | . | . | . | . | . | . | + | . | . | 2 |
| *Phagnalon saxatile* (L.) Cass. | . | . | . | . | . | + | . | . | . | . | + | . | 2 |
| *Ranunculus millefoliatus* Vahl | . | . | . | . | . | . | . | . | 1 | + | . | . | 2 |
| *Daucus carota* L. | . | . | . | . | . | . | . | . | + | + | . | . | 2 |
| *Briza maxima* L. | . | . | . | . | . | . | . | . | . | + | . | + | 2 |
| *Charybdis maritima* (L.) Speta | . | . | . | . | . | . | . | . | . | + | . | + | 2 |
| *Smyrnium olusatrum* L. | 1 | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Oloptum miliaceum* (L.) R.ser et H.R.Hamasha | 1 | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Asphodelus ramosus* L. subsp. *ramosus* | . | . | . | . | + | . | . | . | . | . | . | . | 1 |
| *Dactylis glomerata* L. | . | . | . | . | . | . | . | . | . | . | . | + | 1 |

crops for the extraction of tannins. In the interior of Italy, it is widespread in the thermo-mesomediterranean belt where it forms frutescent formations, more or less dense, tendentially monospecific, related to arid slopes, screes, hedges, and abandoned structures (Gianguzzi and La Mantia 2008). From a phytosociological point of view, it is little studied and not well known. Some shrubby aspects, spread across the coastal slopes of Palermo and Trapani areas, have been attributed to the order *Prunetalia spinosae* Tx. 1952 (Gianguzzi et al. 1996; Gianguzzi and La Mantia 2008). A specific association (*Cercido siliquastri-Rhoetum coriariae* Biondi, Allegrezza & Guitian 1988) was described for the central Apennines (Biondi et al. 1988) and ascribed to the same order of the class *Crataego-Prunetea* Tx. 1962 (*Cytision sessilifolii* Biondi 1988). The association in question – according to other authors (Varol et al. 2006; Karaer et al. 2010; Donmez et al. 2015) who have recognized the structural role of *Rhus coriaria* in the xeric shrubby vegetation of Anatolian Peninsula – has been linked to the order *Pistacio-Rhamnetalia alaterni* of the class *Quercetea ilicis*.

***Description:*** It is a shrubby, paucispecific, xerophilous, heliophilous formation, sometimes shady, dominated by *Rhus coriaria*, which is associated with other elements of the *Oleo-Ceratonion* alliance (*Euphorbia dendroides*, *Olea europaea* var. *sylvestris*, and *Teucrium fruticans*) and other sporadic species of the order *Pistacio-Rhamnetalia alaterni*. On this basis, it is here proposed as a new association belonging to these syntaxa. The coenosis is related to rocky slopes with poor soil, screes, and outcrops of carbonate nature (limestone, dolomite, marl, etc.). In the study area, it extends to the road margins and road cut slopes (Fig. 3E).

***Syndynamism:*** The phytocoenosis covers the detritic slopes of the reliefs of carbonate nature. It is a secondary aspect of the holm oak series of *Rhamno alaterni-Querco ilicis pistacio terebinthi* sigmetosum (Brullo and Marcenò 1985; Gianguzzi et al. 1996; Brullo et al. 2008).

Along the road system of Monte Pellegrino, it belongs to the shady-mesic geosigmetum related to the slopes above the roads. Here, it comes in catenal contact with the following coenoses: a) *Helictotricho convoluti-Ampelodesmetum mauritanici* Minissale 1994 (*Ampelodesmos mauritanicus* grassland); b) *Rhamno alaterni-Quercetum ilicis* Brullo and Marcenò 1985 subass. *pistacietosum terebinthi* Gianguzzi et al. 1996 (chasmo-nitrophilous vegetation of the upper parts of walls in sunny locations, sheltered from cold winds).

***Synchorology:*** This vegetation is frequent on the northern and western sides of Monte Pellegrino, in the Allaura area (Gianguzzi et al. 1996). Other similar aspects are widespread along the northern slopes of the mountains of Palermo area, up to Monte Cofano in the province of Trapani (Gianguzzi and La Mantia 2008).

13) Groupment with *RHAMNUS ALATERNUS* and *PISTACIA TEREBINTHUS*

***Phytosociological data:*** Table 12.

***Diagnostic species:*** *Rhamnus alaternus* (dom.), *Pistacia terebinthus*.

***Description:*** It is a maquis or scrub formation dominated by *Rhamnus alaternus* and *Pistacia terebinthus*, associated with other species of the order *Pistacio-Rhamnetalia alaterni*. This vegetation is linked to the upper parts of old walls (5-10 m high) located on the cool and shady slopes of Contrada Allaura, whose toponym refers to the presence of *Laurus nobilis*, a species quite widespread in Sicily (Marino et al. 2014). Thanks to the lack of maintenance work, it tends to colonize the downhill-side of the roads. It creates a border 2-3 meters high, which in some

cases overhangs the same walls that act as guardwalls. In fact, the roots of woody plants penetrate through the base of the walls into the fill slopes and road bed (Fig. 3F).

***Syndynamism:*** It belongs to the shady-mesic geosigmetum of the road system linked to the northern face of Monte Pellegrino. It is in catenal contact with the following coenoses: a) *Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov. (on lower shady walls); b) *Centranthetum rubri* (on stretches of cool and sheltered walls); c) *Diantho siculae-Helichrysetum panormitani* ass. nov. (on the upper parts of the highest walls).

***Synchorology:*** The vegetation was identified on the northern slopes of Monte Pellegrino, where it forms vegetation strips linked to the upper parts of old retaining walls. Although the phytocoenosis is not very abundant in the area, it has an important documentary value.

## Overall considerations on the results

The resulting dataset is composed of 185 taxa divided into 95 samples (relevés). The mean value of the floristic richness is 30 taxa for the retaining wall communities. The most species-rich of the wall communities are the *Diantho rupicolae-Helichrysetum panormitani* (58 taxa), *Crepido bursifoliae-Parietarietum judaicae* (38 taxa), and *Helichryso panormitanae-Hypochaeridetum laevigatae* (36 taxa). These are followed by *Capparidetum rupestris*, *Antirrhinetum siculi*, *Athamanto siculae-Parietarietum judaicae*, and *Centranthetum rubri*, with 25, 19, 16, and 15 taxa, respectively.

The *Stipellula capensis* guardwall groupment includes 28 taxa. In the road margins, the richest communities are the *Rhamno alaterni-Euphorbietum dendroidis* (52 taxa) and *Olopto miliacei-Pennisetetum setacei* (49 taxa), while the *Rhamno alaterni-Euphorbietum dendroidis* and the groupment with *Rhamnus alaternus* and *Pistacia terebinthus* have 22 and 18 taxa, respectively. The overall mean value for the road margin communities is 35 taxa. The *Scabioso creticae-Centaureetum ucriae* of the road cut slopes is the phytocoenosis with the highest species richness (61 taxa), comparable only to *Diantho rupicolae-Helichrysetum panormitani*.

Species nestedness (the average co-occurrence of species, Table 13) is 8.3 among all the communities of the road system, 8.6 among the retaining wall species, and 10 among the road margin species.

The "Jaccard similarity Index" (Table 14) shows a clear differentiation among phytocoenoses (mean value = 0.15). The mean index values of the vegetation is 0.23 for wall vegetation and 0.19 for road margin vegetation. High values of nestedness (45) and Jaccard's Index (0.61) are observed for *Diantho rupicolae-Helichrysetum panormitani* and *Scabioso creticae-Centauretum ucriae*.

The results obtained from detrended correspondence analysis show a clear distribution of communities. The ordination plot (Fig. 5) shows 95 plots grouped in 13 clusters which are quite distinct from floristic and ecological points of view. The compositional turn-over (the measure of beta diversity; Whittaker 1960) across relevés is 6.51. The wall vegetation plots (phytocoenoses 1-7) are spread over the right part of the ordination diagram. The

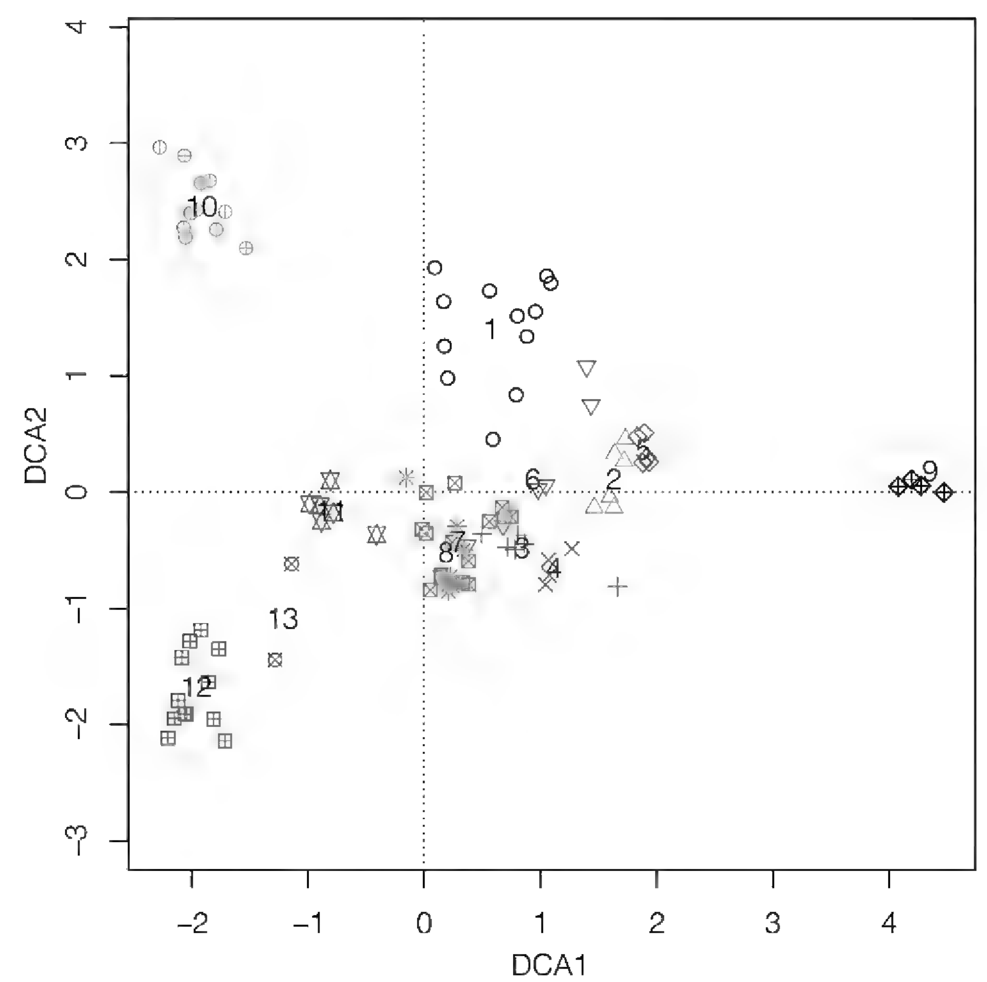


**Figure 5.** DCA ordination of the community of Monte Pellegrino road system. Legend: 1. *Crepido-Parietarietum*; 2. *Athamanto-Parietarietum*; 3. *Helichryso-Hypochaeridetum*; 4. *Centranthetum*; 5. *Antirrhinetum*; 6. *Capparidetum*; 7. *Diantho Helichrysetum*; 8. *Scabioso-Centauretum*; 9. Gr. *Stipellula*; 10. *Olopto-Pennisetetum* 11. *Rhamno-Euphorbietum*; 12. *Teucrio-Rhoetum*; 13. Gr. *Rhamnus* and *Pistacia*.

**Table 12.** Groupment with *Rhamnus alaternus* and *Pistacia terebinthus*.

| | | | |
|---|---|---|---|
| Relevé (n°) | 1 | 2 | |
| Altitude (m) | 80 | 120 | |
| Slope (°) | 90 | 90 | |
| Aspect | N | N | |
| Area ($m^2$) | 40 | 30 | |
| Total cover (%) | 100 | 100 | |
| Average height (cm) | 40 | 40 | |
| Species per relevé | 13 | 17 | Presence |
| **Guide species** | | | |
| *Rhamnus alaternus* L. subsp. *alaternus* | 5 | 5 | 2 |
| *Pistacia terebinthus* L. | 3 | 3 | 2 |
| **Char. of the alliance, order and class** | | | |
| *Euphorbia dendroides* L. | 3 | 2 | 2 |
| *Asparagus acutifolius* L. | 2 | 1 | 2 |
| *Teucrium flavum* L. subsp. *flavum* | + | + | 2 |
| *Artemisia arborescens* L. | 1 | . | 1 |
| *Ampelodesmos mauritanicus* (Poir.) T.Durand et Schinz | . | 1 | 1 |
| *Allium subhirsutum* L. | . | 1 | 1 |
| *Rubia peregrina* L. | . | 1 | 1 |
| *Smilax aspera* L. | . | 1 | 1 |
| *Fraxinus ornus* L. | . | 1 | 1 |
| *Emerus major* Mill. | . | 1 | 1 |
| **Other species** | | | |
| *Acanthus mollis* L. subsp. *mollis* | 2 | 2 | 2 |
| *Phagnalon saxatile* (L.) Cass. | + | 1 | 2 |
| *Eucalyptus camaldulensis* Dehnh. | 2 | 1 | 2 |
| *Pennisetum setaceum* (Forssk.) Chiov. | 3 | . | 1 |
| *Bituminaria bituminosa* (L.) C.H.Stirt. | 1 | . | 1 |
| *Carlina sicula* Ten. | + | . | 1 |
| *Reseda alba* L. | + | . | 1 |
| *Galium cinereum* All. | . | 2 | 1 |
| *Oloptum miliaceum* (L.) Röser et H.R.Hamasha | . | 1 | 1 |
| *Centranthus ruber* (L.) DC. | . | 1 | 1 |

cluster *Diantho rupicolae-Helichrysetum panormitani* (7) overlaps with the cluster of *Scabioso creticae-Centauretum ucriae* (8) of the road cut slopes. The road margin vegetation (from 10 to 13) is placed on the left part of the diagram, while the guardwall vegetation is on the opposite extreme (9). The distribution of communities in the ordination diagram shows an ecological gradient in term of environmental nitrophilia along the second axis.

From a structural point of view, the life form analysis (Table 15) shows the dominance of Hemicryptophytes in the communities linked to the shaded parts of the walls (*Crepido-Parietarietum*, *Athamanto-Parietarietum*, *Helichryso-Hypochaeridetum*) and the vegetation of the road margins (*Olopto-Pennisetetum* and groupment with *Rhamnus* and *Pistacia*). Chamaephytes are dominant in the communities on exposed parts of the walls (*Centranthetum*, *Antirrhinetum* and *Diantho-Helichrysetum*) and the vegetation of road cut slopes (*Scabioso-Centauretum*). Nanophanerophytes are dominant in *Capparidetum* and *Teucrio-Rhoetum*, while phanerophytes are dominant in *Rhamno-Euphorbietum*. The guardwall groupment with *Stipellula* is physiognomized by therophytes.

## Discussion

The phytocoenoses detected along the Monte Pellegrino road system are the result of a process of sponteaneous plant colonization on man-made infrastructure, built in a context of particular naturalistic value. These communities have gradually evolved in an almost undisturbed way, as maintenance has been limited to the sporadic removal or cutting of vegetation only at the road margins and the edges of drainage ditches. The masonry works and rock walls delimiting the uphill and downhill sides of the entire road system have been completely unmaintained.

The rock walls created from the excavation of the limestone substrate, have also been subjected to a slow colonization process by chasmophytic species, typical of natural rock faces, which are also very common in the area. Disturbances of these areas have been limited to the placing of metal mesh in a few sections to stabilize the slope. However, this did not preclude the settlement of rupicolous associations, such as *Scabioso creticae-Centauretum ucriae* (shady-mesic slopes) and *Capparidetum rupestris*

**Table 13.** Shared species ('a' component of the "Jaccard Index") among communities of the road system.

| A value | C-Pa | A-Pa | H-Hy | Cen | Ant | Cap | D-He | S-Ce | g-St | O-Pe | R-Eu | T-Rh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-Pa | 9 | | | | | | | | | | | |
| H-Hy | 10 | 9 | | | | | | | | | | |
| Cen | 6 | 7 | 15 | | | | | | | | | |
| Ant | 8 | 7 | 8 | 6 | | | | | | | | |
| Cap | 8 | 9 | 12 | 8 | 8 | | | | | | | |
| D-He | 11 | 14 | 24 | 11 | 12 | 20 | | | | | | |
| S-Ce | 11 | 9 | 21 | 10 | 10 | 17 | 45 | | | | | |
| g-St | 3 | 6 | 4 | 2 | 7 | 3 | 5 | 3 | | | | |
| O-Pe | 11 | 2 | 5 | 0 | 5 | 4 | 11 | 10 | 1 | | | |
| R-Eu | 2 | 1 | 5 | 1 | 4 | 4 | 13 | 12 | 1 | 7 | | |
| T-Rh | 8 | 3 | 9 | 3 | 2 | 5 | 16 | 17 | 1 | 10 | 9 | |
| g-Rh | 3 | 2 | 8 | 3 | 3 | 4 | 15 | 12 | 1 | 7 | 10 | 17 |

**Table 14.** "Jaccard similarity Index" among communities of the road system.

| Jaccard | C-Pa | A-Pa | H-Hy | Cen | Ant | Cap | D-He | S-Ce | g-St | O-Pe | R-Eu | T-Rh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-Pa | 0.20 | | | | | | | | | | | |
| H-Hy | 0.16 | 0.21 | | | | | | | | | | |
| Cen | 0.13 | 0.29 | 0.43 | | | | | | | | | |
| Ant | 0.16 | 0.25 | 0.17 | 0.21 | | | | | | | | |
| Cap | 0.15 | 0.28 | 0.25 | 0.25 | 0.22 | | | | | | | |
| D-He | 0.13 | 0.23 | 0.35 | 0.18 | 0.18 | 0.32 | | | | | | |
| S-Ce | 0.13 | 0.13 | 0.28 | 0.15 | 0.14 | 0.25 | 0.61 | | | | | |
| g-St | 0.05 | 0.16 | 0.07 | 0.05 | 0.18 | 0.06 | 0.06 | 0.04 | | | | |
| O-Pe | 0.15 | 0.03 | 0.06 | 0.00 | 0.08 | 0.06 | 0.12 | 0.10 | 0.01 | | | |
| R-Eu | 0.04 | 0.03 | 0.10 | 0.03 | 0.12 | 0.10 | 0.21 | 0.18 | 0.02 | 0.12 | | |
| T-Rh | 0.10 | 0.05 | 0.12 | 0.05 | 0.03 | 0.07 | 0.17 | 0.18 | 0.01 | 0.11 | 0.15 | |
| g-Rh | 0.05 | 0.06 | 0.16 | 0.09 | 0.08 | 0.09 | 0.23 | 0.17 | 0.02 | 0.11 | 0.33 | 0.30 |

**Table 15.** Life form of the communities of the road system (C-Pa: *Crepido-Parietarietum*; A-Pa: *Athamanto-Parietarietum*; H-Hy: *Helichryso-Hypochaeridetum*; Cen: *Centranthetum*; Ant: *Antirrhinetum*; Cap: *Capparidetum*; D-He: *Diantho-Helichrysetum*; S-Ce: *Scabioso-Centauretum*; 9. F-St: gr. *Stipellula*; O-Pe: *Olopto-Pennisetetum*; R-Eu: *Rhamno-Euphorbietum*; T-Rh: *Teucrio-Rhoetum*; g-Rh: Gr. *Rhamnus* and *Pistacia*).

| Flora | C-Pa | A-Pa | H-Hy | Cen | Ant | Cap | D-He | S-Ce | g-St | O-Pe | R-Eu | T-Rh | g-Rh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CH | 7.9 | 6.3 | 25.7 | 33.3 | 10.5 | 28.0 | 29.3 | 29.5 | 0.0 | 4.2 | 16.7 | 9.6 | 13.6 |
| G | 10.5 | 18.8 | 11.4 | 20.0 | 5.3 | 4.0 | 8.6 | 11.5 | 7.4 | 8.3 | 0.0 | 9.6 | 4.5 |
| H | 28.9 | 31.3 | 22.9 | 20.0 | 15.8 | 20.0 | 22.4 | 24.6 | 11.1 | 47.9 | 22.2 | 26.9 | 27.3 |
| NP | 2.6 | 0.0 | 5.7 | 6.7 | 10.5 | 8.0 | 13.8 | 11.5 | 0.0 | 2.1 | 27.8 | 19.2 | 22.7 |
| P | 2.6 | 6.3 | 5.7 | 0.0 | 0.0 | 8.0 | 6.9 | 3.3 | 0.0 | 2.1 | 27.8 | 26.9 | 13.6 |
| T | 47.4 | 37.5 | 28.6 | 20.0 | 57.9 | 32.0 | 19.0 | 19.7 | 81.5 | 35.4 | 5.6 | 7.7 | 18.2 |

| Freq. | C-Pa | A-Pa | H-Hy | Cen | Ant | Cap | D-He | S-Ce | g-St | O-Pe | T-Rh | R-Eu | g-Rh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CH | 9.6 | 7.3 | 27.4 | 29.2 | 13.5 | 31.8 | 44.4 | 42.4 | 0.0 | 1.9 | 11.3 | 9.4 | 16.7 |
| G | 10.5 | 12.7 | 13.2 | 18.8 | 6.8 | 4.5 | 4.1 | 9.1 | 2.4 | 7.8 | 0.0 | 9.8 | 3.3 |
| H | 32.5 | 38.2 | 24.5 | 25.0 | 18.9 | 21.2 | 23.7 | 21.8 | 6.1 | 60.2 | 27.4 | 23.0 | 23.3 |
| NP | 1.8 | 0.0 | 2.8 | 4.2 | 4.1 | 12.1 | 8.7 | 11.5 | 0.0 | 1.5 | 32.3 | 19.6 | 23.3 |
| P | 0.9 | 3.6 | 5.7 | 0.0 | 0.0 | 3.0 | 3.3 | 1.8 | 0.0 | 2.4 | 25.8 | 27.7 | 16.7 |
| T | 44.7 | 38.2 | 26.4 | 22.9 | 56.8 | 27.3 | 15.8 | 13.3 | 91.5 | 26.2 | 3.2 | 10.6 | 16.7 |

| Cover | C-Pa | A-Pa | H-Hy | Cen | Ant | Cap | D-He | S-Ce | g-St | O-Pe | T-Rh | R-Eu | g-Rh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CH | 0.6 | 1.0 | 7.5 | 74.9 | 75.7 | 13.6 | 87.4 | 86.7 | 0.0 | 0.2 | 1.7 | 6.9 | 0.0 |
| G | 0.6 | 1.6 | 3.6 | 2.4 | 2.1 | 0.7 | 0.8 | 2.0 | 0.3 | 10.4 | 0.0 | 9.7 | 24.4 |
| H | 91.8 | 88.5 | 79.7 | 7.4 | 5.7 | 3.6 | 5.7 | 5.1 | 0.7 | 85.0 | 34.6 | 9.7 | 66.5 |
| NP | 0.1 | 0.0 | 0.7 | 0.7 | 1.2 | 77.3 | 2.1 | 2.8 | 0.0 | 0.2 | 57.8 | 9.0 | 0.2 |
| P | 0.0 | 0.4 | 1.7 | 0.0 | 0.0 | 0.4 | 0.8 | 0.5 | 0.0 | 0.3 | 5.7 | 57.6 | 0.5 |
| T | 6.7 | 8.4 | 6.8 | 14.6 | 15.3 | 4.4 | 3.2 | 3.0 | 99.0 | 3.9 | 0.2 | 7.2 | 8.3 |

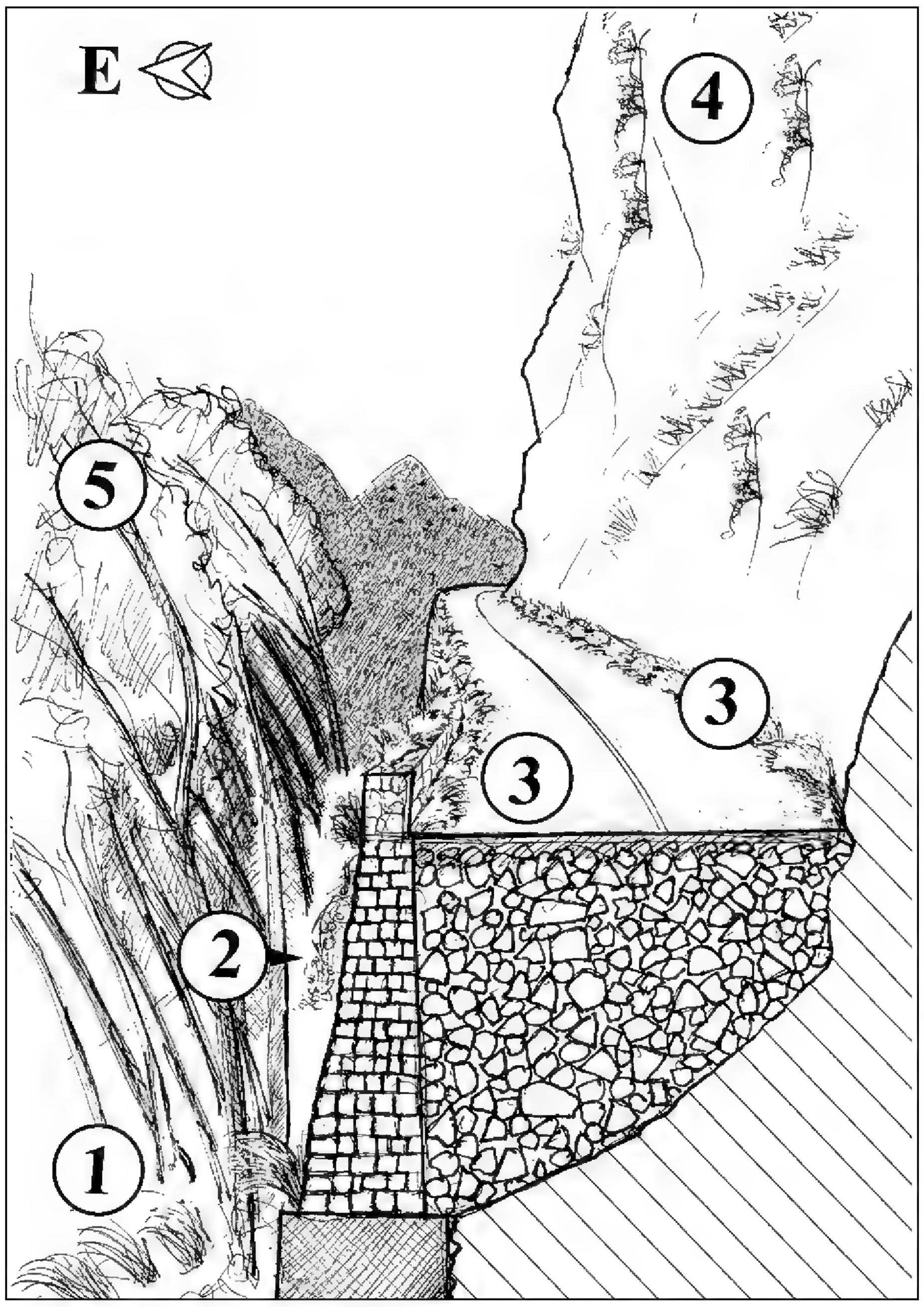


**Figure 6.** Schematic transect of the xeric geosigmetum of the Monte Pellegrino road system (via Pietro Bonanno, on the slopes of Arenella before the hairpin bend overlooking Palermo, 120 m a.s.l.): 1) grassland vegetation with *Pennisetum setaceum* (*Penniseto setacei-Hyparrhenietum hirtae*); 2) thermo-chasmophytic wall vegetation with *Capparis spinosa* (*Capparidetum rupestris*); 3) road margin hemicryptophytic, nitrophilous vegetation with *Pennisetum setaceum* (*Olopto miliacei-Pennisetetum setacei* ass. nov.); 4) chasmophytic cliff vegetation with *Lomelosia cretica* (*Scabioso-Centauretum ucriae*); 5) artificial forest plantations with *Eucalyptus camaldulensis* and *Pinus halepensis*.

Overall, depending on the microclimatic diversification of the Monte Pellegrino promontory where the roadway under investigation was built, it is possible to distinguish two different microgeoseries of the road system: respectively a xerophilous and a shady-mesic one.

The xerophilous microgeoseries can be found along the stretches of the southern and western slopes, starting from the foot of the mountain, the so-called "falde di Monte Pellegrino". The most representative features (xeric slopes), both previously noted in this area (Brullo and Marcenò 1979; Gianguzzi et al. 1996).

The syndynamic diversification of the road system is primarily related to the main habitats characterizing the individual stretches of road, such as retaining walls, road embankments and rocky walls, masonry guardwalls and road margins.

Indeed, it can be observed that, under conditions of microtopographic homogeneity in a road section (e.g., along the straightaways), the phytocoenoses tend to maintain their homogeneity. On the contrary, as certain ecological factors vary (slope, exposure of the individual stretch of road, altitude, available shade, nitrophilia, availability or lack of nutrients, etc.), the arrangement of the coenoses tends instead to vary with substitutions or interpenetrations.

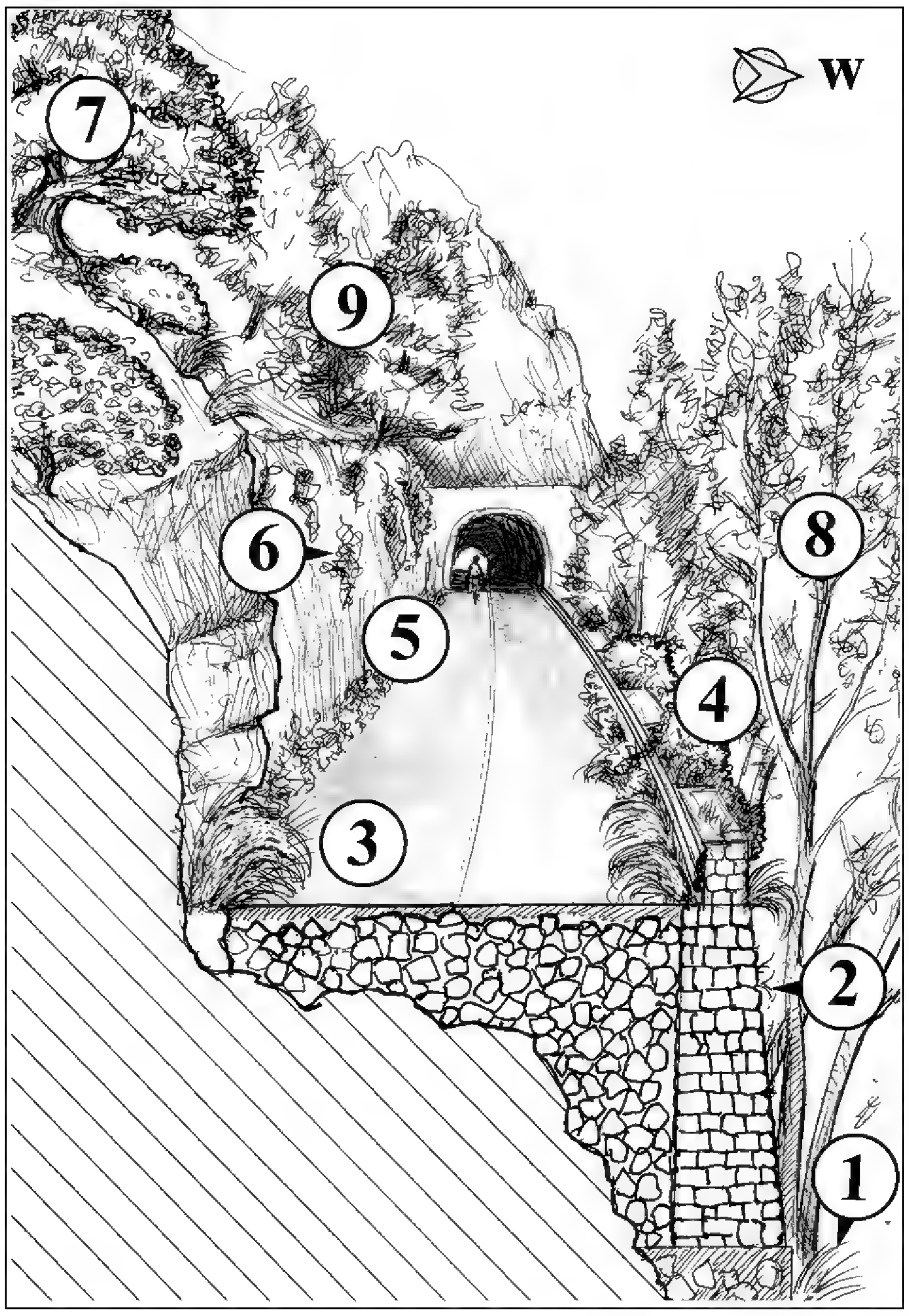


**Figure 7.** Schematic transect of the xeric geosigmetum of the Monte Pellegrino road system (upper part of via Monte Ercta, near the tunnel on the slopes above the Favorita park of Palermo, 310 m a.s.l.): 1) grassland vegetation with *Pennisetum setaceum* (*Penniseto setacei-Hyparrhenietum hirtae*); 2) chamaephytic wall vegetation dominated by *Antirrhinum siculum* (*Antirrhinetum siculi*); 3) hemichryptophytic nitrophilous vegetation of the road margins with *Pennisetum setaceum* (*Olopto miliacei-Pennisetetum setacei* ass. nov.); 4) nitro-xerophilous vegetation with *Euphorbia dendroides* and *Artemisia arborescens* (*Rhamno-Euphorbietum artemisietosum arborescentis* subass. nov.); 5) chasmo-nitrophilous, sciaphilous vegetation with *Parietaria judaica* (*Crepido bursifoliae-Parietarietum judaicae* ass. nov.); 6) chasmophytic coenosis with *Lomelosia cretica* (*Scabioso-Centauretum ucriae*); 7) vegetation with *Olea europaea* var. *sylvestris* (*Ruto chalepensis-Oleetum sylvestris*); 8) artificial forest plantation with *Eucalyptus camaldulensis*; 9) artificial forest plantation with *Pinus halepensis*.

of this microgeoseries are schematized in Fig. 6 and Fig. 7. The relevant area falls within the range of the xerophilous series of *Ruto chalepensis-Oleo sylvestris* sigmetum (Gianguzzi and Bazan 2019, 2020; Gianguzzi et al. 2020), consisting of an oleaster formation (*Ruto-Oleetum sylvestris*), secondary aspects of *Euphorbia dendroides* maquis (*Rhamno-Euphorbietum dendroidis euphorbietosum bivonae*), *Pennisetum setaceum* grassland (*Penniseto setacei-Hyparrhenietum hirtae*) and therophitic grasslands of the class *Stipo-Trachynietea distachyae* (Fig. 3e).

The shady-mesic microgeoseries of the road system is, instead, found on the northern slope of the promontory; its exemplary characteristics are schematized in Fig. 8 and Fig. 9. It falls within the context of the *Rhamno alaterni-Querco ilicis pistacietosum terebinthi* sigmetosum series

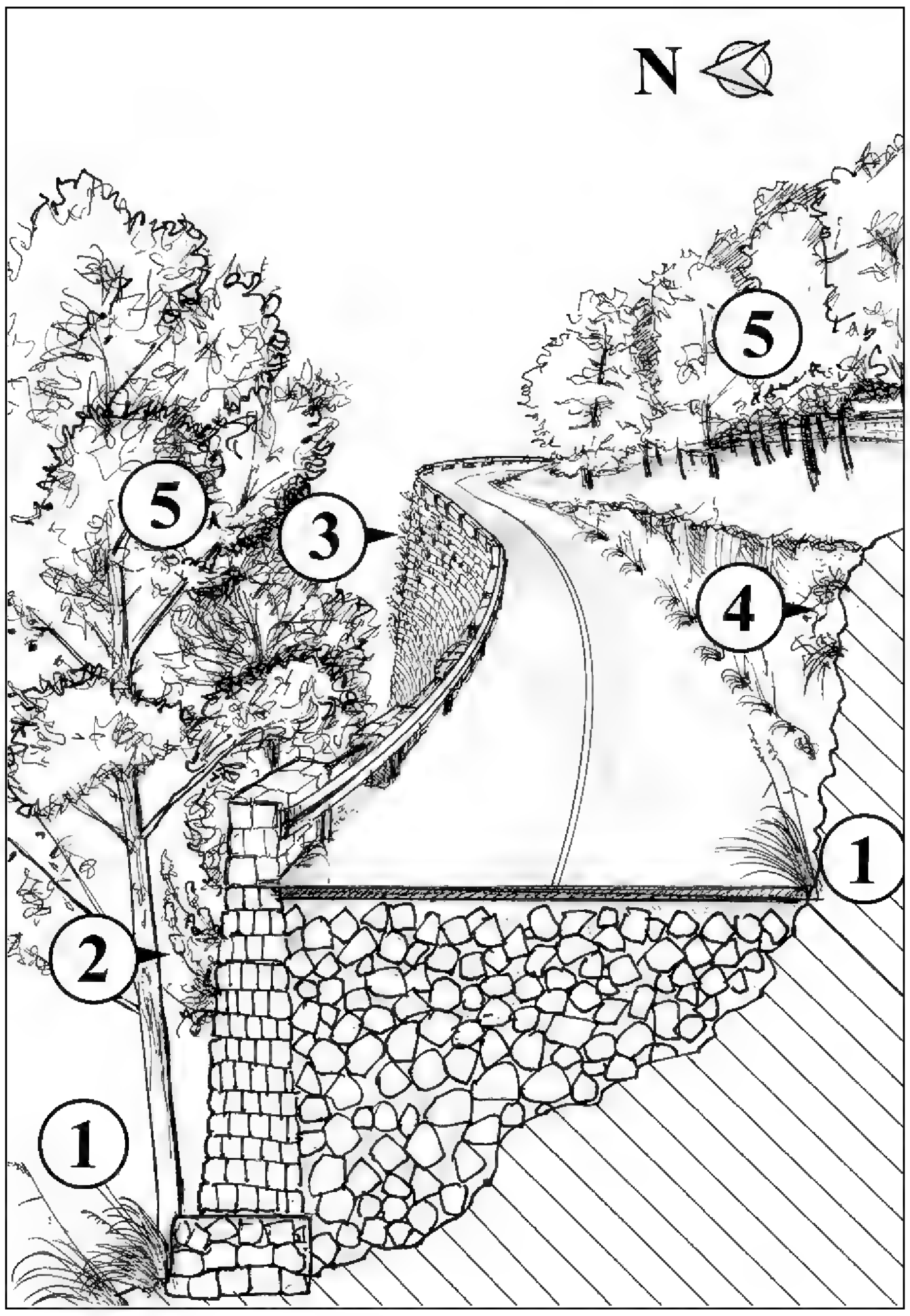


**Figure 8.** Schematic transect of the shady-mesic geosigmetum of the Monte Pellegrino road system (via Monte Ercta, descending toward Mondello, at the first harpin bend in the slopes above Contrada Allaura, 240 m a.s.l.): 1) grassland with A*mpelodesmos mauritanicus* (*Helictotricho-Ampelodesmetum mauritanici*); 2) chasmo-nitrophilous, heliophilous coenosis of lower and cooler walls with *Centranthus ruber* (*Centranthetum rubri*); 3) chasmophytic, heliophilous vegetation of higher old and cool walls with *Helichrysum panormitanum* subsp. *panormitanum* (*Diantho siculae-Helichrysetum panormitani* ass. nov.); 4) chasmophytic coenosis with *Lomelosia cretica* (*Scabioso-Centauretum ucriae*); 5) artificial forest plantation with *Pinus halepensis*.

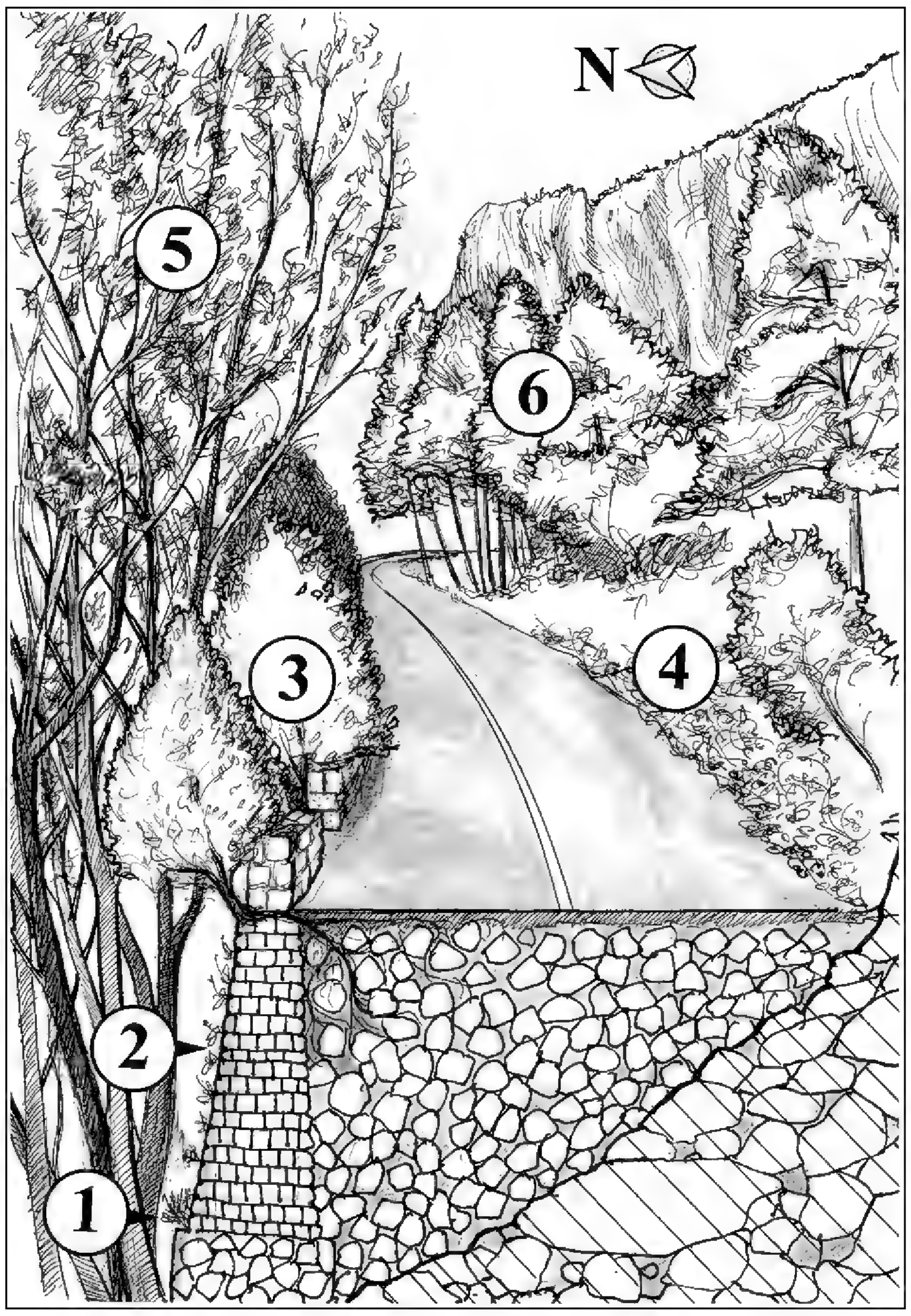


**Figure 9.** Schematic transect of the shady-mesic geosigmetum of the Monte Pellegrino road system (via Monte Ercta, at the last harpin bend on the slopes above Contrada Allaura, descending toward Mondello, 120 m a.s.l.): 1) chasmo-nitrophilous with Parietaria judaica (*Crepido bursifoliae-Parietarietum judaicae* ass. nov.); 2) cemicryptophytic-camaephytic, sciaphilous vegetation on old walls with *Hypochaeris laevigata* (*Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov.); 3) nitrophilous maquis of old walls (*Rhamnus alaternus* and *Pistacia terebinthus* groupment); 4) secondary maquis of detritic slopes (*Teucrio flavi-Rhoetum coriariae* Gianguzzi ass. nov.); 5) artificial forest plantation with *Eucalyptus camaldulensis*; 6) artificial forest plantation with *Pinus halepensis*.

(Gianguzzi et al. 1996; Brullo et al. 2008), which is made up of holm oak woods (*Rhamno alaterni-Querco ilicis* subass. *pistacietosum terebinthi*), *Rhus coriaria* shrubland (*Teucrio flavi-Rhoetum coriaria* Gianguzzi ass. nov.), *Ampelodesmos mauritanicus* grassland (*Helictotricho-Ampelodesmetum mauritanici*), and therophitic grasslands of the class *Stipo-Trachynietea distachyae*.

Among the new associations described, two of them concern communities dominated by *Parietaria judaica* (*Crepido bursifoliae-Parietarietum* ass. nov. and *Athamanto siculae-Parietarietum* ass. nov.), related to different areas of the masonry structures. Here, in fact, the widespread presence of the aforementioned vital and invasive dominant species tends to impose similar physiognomies

on different ecological contexts, making it difficult to concretely identify phytocoenoses. However, those which are settled at the base tend to have a floristic composition rich in synanthropic and ruderal elements of the classes *Stellarietea*, *Lygeo-Stipetea* (*Bromo-Oryzopsion*) and *Polygono-Poetea annuae*, differently from the slightly higher parts of the walls. There, in fact, the *Parietaria* vegetation reveals a total absence of such elements and is, instead, enriched with other, rather rare chasmophytic species of the class *Asplenietea trichomanis* (e.g., *Athamanta sicula*), allowing a clear diversification of the coenoses.

Generally, plant communities growing on these kinds of walls normally form anthropogenic coenoses characterized by nitrophilic and nutrient needy plants as they are subjected to the crumbling of their underlying materials (rocks and mortar) which allow for the fertilization and humidification of the surfaces. The wall plants thus tend to form relatively unstable formations in the long term, also due to anthropic disturbances (cleaning, restoration, reconstruction, etc.) which benefit neophytes and species arriving via anthropochory dissemination (Bartolo and Brullo 1986; Brullo and Guarino 1998, 2002).

Along the old walls of the Monte Pellegrino road system, conversely, the absence of these human disturbances has led, over time, to the establishment of communities that are partly unique, as in the case of *Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov. and *Diantho siculae-Helichrysetum panormitani* Gianguzzi ass. nov., both dominated by *Asteraceae* with anemophilous distribution. These are two peculiar, endemic coenoses of this local area.

Among the vegetation aspects of the road margins, *Olopto miliacei-Pennisetetum setacei* Gianguzzi ass. nov. stands out. This is a nitrophilic-ruderal coenosis of the *Bromo-Oryzopsion miliaceae* alliance, dominated by *Pennisetum setaceum*, a rapidly expanding invasive exotic along the coastal roads of Sicily, linked to the more xeric bioclimatic zone. On the road embankments of the northern slope, it is substituted by vegetation dominated by *Ampelodesmos mauritanicus* (*Helictotricho convoluti-Ampelodesmetum mauritanici*), presenting prairie aspects linked to the holm oak series (*Rhamno alaterni-Querco ilicis* sigmetum). The shrubby phytocoenoses linked to the less disturbed road margins are: *Rhamno alaterni-Euphorbietum dendroidis artemisietosum arborescentis* subss. nov., *Teucrio flavi-Rhoetum coriariae* Gianguzzi ass. nov., and a maquis dominated by *Rhamnus alaternus* and *Pistacia terebinthus*, while the chasmophytic associations tied to rupicolous habitat are *Capparidetum rupestris* and *Scabioso creticae-Centauretum ucriae*.

The phytosociological analysis of the various anthropogenic habitats (masonry retaining wall, masonry guardwall, road margins, rock cut slope) has shown that these communities, though autonomous, have floristic relationships and affinities both with the natural phytocoenoses of Monte Pellegrino, external to the road system, and with the phytocoenoses of the other habitats that are part of the road system. The latter, in fact, develop in contact with each other within the habitat sequence.

Among the natural phytocoenoses, there are mainly rupicolous communities, grassland and Mediterranean maquis formations, which are quite extended throughout the promontory. They constitute the source habitats of the main species which, in turn, play an important pioneer role in the gradual colonization process of the artificial micro-habitats characterizing the road system. These are closely related phytocoenoses, which differ according to variations of ecological gradient within the sequence in the respective geosigmeta.

## Concluding considerations

The phytosociological study of the vegetation connected to the Monte Pellegrino road system allowed us to differentiate 10 associations, 1 sub-association and 2 groupment, in turn ascribed to 5 different classes of vegetation. These plant communities settled down through a slow colonization process that lasted about a century, distributed across the artificial microhabitats of the route according to the topography and the microclimatic factors of the sites. Recent anthropogenic factors (direct and indirect) are of limited significance, restricted to sporadic cleaning of the road margins and slopes. There was no maintenance of the retaining walls, where chasmophytic vegetation was able to settle and evolve undisturbed. It should also be noted that the disturbance of the wall vegetation by fires was almost nonexistent given their low frequency in the area. On this basis, peculiar and endemic phytocoenoses could also develop, such as *Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov. and *Diantho siculae-Helichrysetum panormitani* Gianguzzi ass. nov.

The different phytocoenoses detected reflect the high number of microhabitats present in the road system under investigation, which are differentiated according to the slopes and the altitude of this suburban road. Some of these communities have been described as new associations or sub-associations, while other chasmophytic formations (e.g., *Centranthetum rubri* and *Antirrhinetum siculi)* were not reported for this area in a previous contribution on vegetation (Gianguzzi et al. 1996).

The chasmophytic vegetation includes some phytocoenoses whose microtopographic location is closely linked to the different conditions present along the profile of the walls and rock faces. In fact, the species that grow towards the base are normally more numerous than those that are typical of the upper parts of the walls, where survival is more difficult. This is due, above all, to a lack of suitable hollows – which are also poor in soil, moisture, and useful nutrients – in addition to more direct wind exposure and a higher temperature range (daily and annual). This obviously made the initial establishment, as well as the growth and development of plants, more difficult. Additionally, the dispersion of seeds – regardless of the diffusion vector, biotic (animals, insects, etc.) or abiotic (wind, water, etc.) – as well as germination tend to decrease in almost direct proportion to distance from the ground.

In the floristic settlement of the coenoses there are several exotic and alien species (e.g., *Boerhavia repens*, *Pennisetum setaceum*, *Oxalis pes-caprae*, etc.), some of which are even dominant and characteristic of specific plant communities (*Penniseto setacei-Hyparrhenietum hirto-pubescentis*, Gianguzzi et al. 1996 and *Olopto miliacei-Pennisetetum setacei* Gianguzzi ass. nov.). This is in addition to other species and communities which have already been reported for the promontory, such as *Ricinus communis*, *Ailanthus altissima*, *Opuntia stricta*, *O. dillenii*, *Agave americana*, *A. sisalana*, *Nicotiana glauca*, *Arundo donax*, *Vachellia karroo*, *Parkinsonia aculeata*, *Asparagus asparagoides*, etc. (Gianguzzi et al. 1996). In this sense, road networks act as corridors for the diffusion of alien species as evidenced by the presence of these non-native invasive plants.

It can therefore be said that the Monte Pellegrino promontory acts as a refuge site in both floristic and coenological terms, in particular on the more xeric (southern and western) slopes. Some of these elements are even in the process of expansion, having found important ecological spaces, and not only on Monte Pellegrino; this is the case of *Pennisetum setaceum* which, in addition to being invasive to grassland (with the association *Penniseto setacei-Hyparrhenietum hirtae*, which is also increasing on neighboring hills, such as Monte Gallo, Monte Palmeto, Monte Pecoraro, etc.), also tends to expand along the road margins of the most xeric areas of Sicily.

In conclusion, the Monte Pellegrino promontory, despite some current threats, retains floristic and phytocoenotic distinctiveness and good coenological diversity which is partly of anthropogenic nature. On the basis of these considerations, it can be confirmed that suburban and rural road systems created with traditional techniques can sometimes take on important roles as reservoirs of biodiversity.

## Syntaxonomic scheme

Phytosociological and statistical analyses of the vegetation allowed us to organize the phytocoenoses listed in the following syntaxonomic scheme.

CYMBALARIO-PARIETARIETEA DIFFUSAE Oberd. 1969
*TORTULO-CYMBALARIETALIA* Segal 1969
**Galio valantiae-Parietarion judaicae** Rivas-Mart. ex O. de Bolòs 1967
*Crepido bursifoliae-Parietarietum judaicae* ass. nov.
*Athamanto siculae-Parietarietum judaicae* ass. nov.
*Helichryso panormitanae-Hypochaeridetum laevigatae* ass. nov.
*Centranthetum rubri* Oberd. 1969
*Antirrhinetum siculi* Bartolo & Brullo 1986
**Artemisio arborescentis-Capparidion spinosae** Biondi, Blasi et Galdenzi in Biondi *et al.* 2014
*Capparidetum rupestris* O. Bolòs & Molinier 1958

ASPLENIETEA TRICHOMANIS (Br.-Bl. in Mei. & Br.-Bl. 1934) Ober. 1977
*ASPLENIETALIA GLANDULOSI* Br.-Bl. & Meier in Meier & Br.-Bl. 1934
**Dianthion rupicolae** Brullo & Marcenò 1979
*Diantho siculae-Helichrysetum panormitani* Gianguzzi ass. nov.
*Scabioso creticae-Centauretum ucriae* Brullo & Marcenò 1979

STIPO-TRACHYNIETEA DISTACHYAE S. Brullo in S. Brullo *et al.* 2001
*BRACHYPODIETALIA DISTACHYAE* Rivas-Martínez 1978
**Hypochoeridion achyrophori** Biondi & Guerra 2008
Groupment with *Stipellula capensis*

ARTEMISIETEA VULGARIS Lohmeyer *et al.* in Tx. Ex von Rochow 1951
*ELYTRIGIO REPENTIS-DITTRICHIETALIA VISCOSAE* Mucina in Mucina *et al.* 2016
**Bromo-Oryzopsion miliaceae** O. Bolòs 1970
*Olopto miliacei-Pennisetetum setacei* Gianguzzi ass. nov.

QUERCETEA ILICIS Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
*PISTACIO LENTISCI-RHAMNETALIA ALATERNI* Rivas-Martínez 1975
**Oleo sylvestris-Ceratonion siliquae** Br.-Bl. ex Guinochet & Drouineau 1944
*Rhamno alaterni-Euphorbietum dendroidis* Géhu & Biondi 1997
*artemisietosum arborescentis* subass. nov.
*Teucrio flavi-Rhoetum coriariae* Gianguzzi ass. nov.
Groupment with *Rhamnus alaternus* and *Pistacia terebinthus*

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## Competing interests

The authors have declared that they have no competing interests.

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# Appendix - Location and dates of relevés

**Table 1** – *Crepido bursifoliae-Parietarietum judaicae:* Rels. 1-4, Palermo (14.5.2016); Rels. 5-7, via Bonanno (foot of M. Pellegrino): base of masonry and rock walls on the sea side (12.6.2016); Rels. 8-9, via Monte Ercta near

the second tunnel, under the rock wall (10.5.2016); Rels. 10-12, Grotta di St. Rosalia square, at the base of a wall (10.6.2016).

**Table 2** – *Athamanto siculae-Parietarietum judaicae*: Rels. 1-2, via Bonanno, retaining wall near the Utveggio castle (10.6.2019); Rels. 3-6, Wall in the square in front the St. Rosalia Sanctuary (10.6.2019).

**Table 3** – *Helichryso panormitanae-Hypochaeridetum laevigatae*: Rels. 1-3, Walls above the hairpin bend of Contrada Allaura (10.5.2019); Rel. 4, Wall above Cda Allaura (10.5.2019); 5-6, Wall in the slope above Mondello.

**Table 4** – *Centranthetum rubri*: Rels. 1-4, Walls above the Contrada Allaura (21.4.2016);

**Table 5** – *Antirrhinetum siculi*: Rels. 1-2, Road to the antennas (18.5.2016); 3-4, via M. Ercta (21.5.2017); 5, Road to the antennas (21.5.2017).

**Table 6** – *Capparidetum rupestris*: Rels. 1-2, Wall above the Contrada Arenella (18.5.2016); Rels. 3-4, Wall before the last hairpin bend above the Contrada Arenella (18.5.2016); 5-6, Wall of Contrada Arenella (by Gianguzzi et al. 1993).

**Table 7** – *Diantho rupicolae-Helichrysetum panormitani*: Ril. Rels. 1-15, Hight walls of via Monte Ercta, between the Contrada Allaura and the Sanctuary (10.6.2016).

**Table 8** – *Scabioso creticae-Centauretum ucriae* Brullo et Marcenò 1979 subass. *typicum*: Rel. 1, Mountain-side wall near the first hairpin bend before the Favorita (21.4.2016); Rel. 2, Mountain-side wall at the first hairpin bend above Mondello; Rels. 3-4, Mountain-side wall before the last tunnel (4.5.2016); Rels. 5-7, Mountain-side wall, shortly before the Santuary (4.5.2016).

**Table 9** – Groupment with *Stipellula capensis*: Rels. 1-2, Old walls (parapets) along via Bonanno, above the Arenella side (10.5.2018); Rels. 3-4, parapets along the old road to the Sanctuary (10.6.2019)

**Table 10** – *Rhamno alaterni-Euphorbietum dendroidis* Géhu & Biondi 1997 subass. *artemisietosum arborescenti*: Rels. 1-2, via Bonanno (12.6.2016); Rels. 3-6, via Monte Ercta (12.6.2016).

**Table 11** – *Teucrio flavi-Rhoetum coriariae*: Rels. 1-2, Detritic slopes along the road to Monte Pellegrino at Contrada Allaura near the first tunnel (10.6.2016); Rels. 3-6, clearing of Allaura woodland (25.6.1995; by Gianguzzi et al. 1996, Tab. 7); Rels. 7-8, Monte Cofano Natural Reserve, at Contrada Frassino (15.02.2001; by Gianguzzi and La Mantia, 2008); 9-11: Villagrazia di Carini, under the cliffs of Montagna Longa (15.05.2001; by Gianguzzi and La Mantia, 2008 ); 12, Monte Pellegrino, in the clearing of Allaura woodland (25.06.1995; by Gianguzzi and La Mantia, 2008).

**Table 12** – Groupment with *Rhamnus alaternus* e *Pistacia terebinthus*: Rels. 1-2, via Monte Ercta, along the wall of Contrada Allaura (12.6.2016).